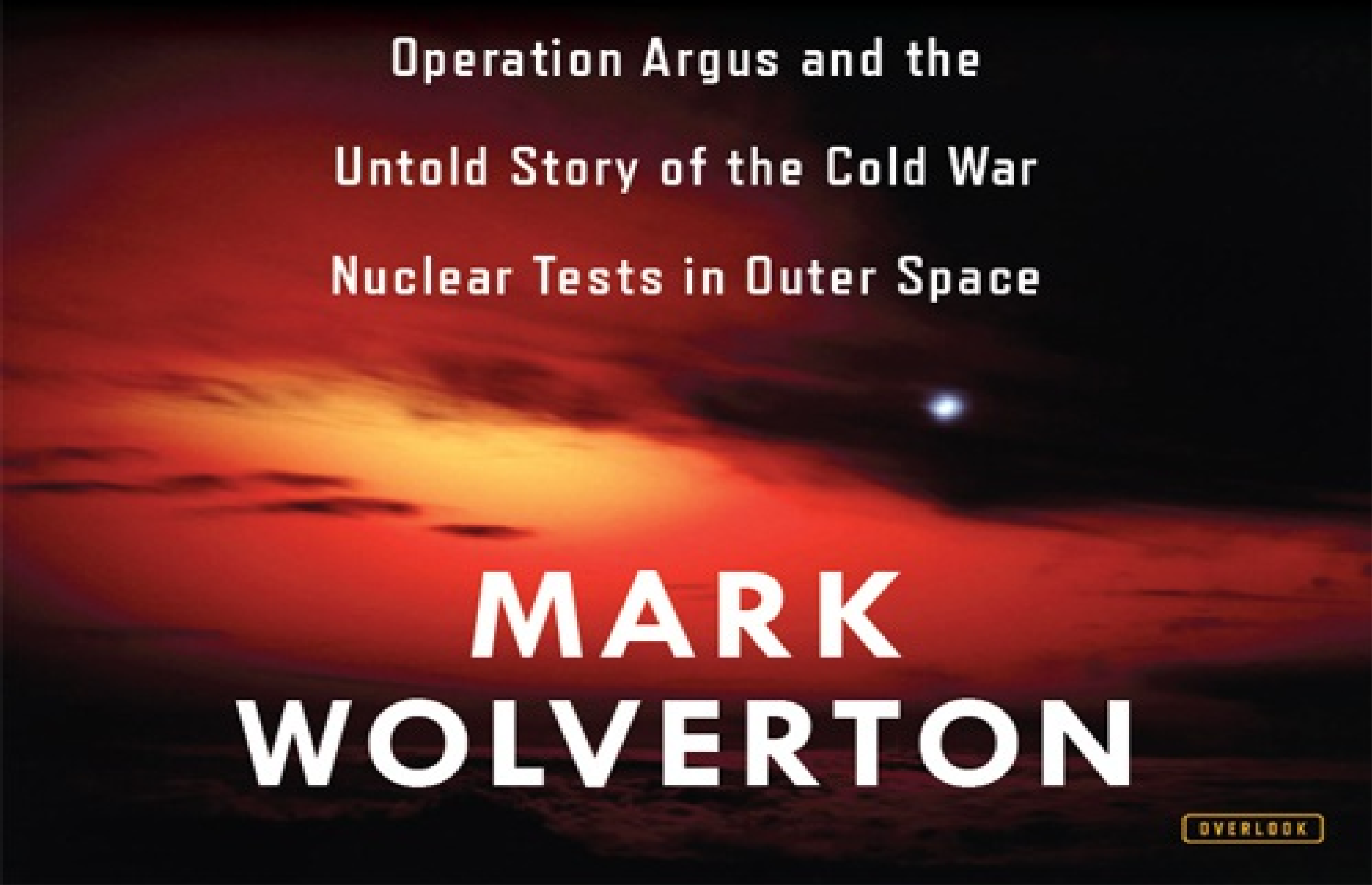
BURNING THE SKY

Operation Argus and the Untold Story of the Cold War Nuclear Tests in Outer Space



MARK WOLVERTON

OVERLOOK

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Operation Argus and the Untold Story of the Cold War Nuclear Tests in Outer Space

MARK WOLVERTON

with 21 b&w and 9 color images and 5 maps

After the Soviet Union proved to the US that it possessed an operational intercontinental ballistic missile with the launch of Sputnik in October 1957, the world watched anxiously as the two superpowers engaged in a game of nuclear one-upmanship. In the midst of this rising tension, Nicholas Christofilos, an eccentric Greek-American physicist, brought forth an outlandish, albeit ingenious, idea to defend the US from a Soviet attack: launching nuclear warheads to detonate in outer space, creating an artificial radiation belt that would fry incoming Soviet ICBMs. That idea became Operation Argus, the most secret and riskiest scientific experiment in history, and classified details of these nuclear tests have been long obscured.

In *Burning the Sky*, Mark Wolverton tells the unknown and controversial story of this scheme to reveal a fascinating narrative that still has powerful resonances today. He chronicles Christofilos's unconventional idea from its inception to execution, when the scientist persuaded the military to carry out the dangerous test—using the entire Earth's atmosphere as a laboratory. Combining his investigation of recently declassified military documents with more than a decade of experience in researching and writing about the science of the Cold War, Wolverton examines the scientific, political, and environmental implications of Argus, as well as that of the atmospheric tests that followed. He also discusses the roles played by physicist James Van Allen and President Eisenhower in the scheme, and how the whistleblowing journalists at the *New York Times* blew the lid off what was supposed to be America's ultimate nuclear secret.

Burning the Sky is an engrossing read that will intrigue any lover of scientific or military history and will remind readers why Operation Argus remains frighteningly relevant nearly sixty years later.

ALSO BY MARK WOLVERTON

A Life in Twilight:
The Final Years of J. Robert Oppenheimer

The Depths of Space:
The Story of the Pioneer Planetary Probes

The Science of Superman:
The Official Guide to the Science of
the Last Son of Krypton

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The national security complex became, in the Eisenhower years, a fast-growing apparatus to allow us to do in secret what we could not do in the open.

—DAVID HALBERSTAM, The Fifties

There is the sky, which is all men's together.

—EURIPIDES

Earth changed in the black sky.

It caught fire.

Part of it seemed to come apart in a million pieces, as if a gigantic jigsaw had exploded. It burned with an unholy dripping glare for a minute, three times normal size, then dwindled.

"What was that?" Sam looked at the green fire in the sky.

"Earth," said Elma, holding her hands together.

"That can't be Earth, that's not Earth! No, that ain't Earth! It can't be."

"You mean it couldn't be Earth," said Elma, looking at him. "That just isn't Earth. No, that's not Earth; is that what you mean?"

"Not Earth—oh no, It couldn't *be," he wailed.*

He stood there, his hands at his sides, his mouth open, his eyes wide and dull, not moving.

—RAY BRADBURY, The Martian Chronicles

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Also by Mark Wolverton
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Introduction:
The Middle of Nowhere

ASIDE FROM THE TRISTAN DA CUNHA ARCHIPELAGO, CONSISTING OF THE MAIN island of Tristan da Cunha, the Nightingale islands, Gough Island, and Inaccessible Island, most of the various other tiny chunks of rock in the South Atlantic Ocean are so small and insignificant that no one has ever bothered to grace them with proper names. Only about three hundred people have ever resided permanently on Tristan da Cunha at any given time, and most of the other islands are either wholly uninhabited by humans or populated only intermittently by small scientific or meteorological crews. The islands have been a territory of the United Kingdom since the early nineteenth century, and over the years have sheltered visiting fishermen, whalers, naturalists, fugitives, and even an occasional prince or other royalty.

On the morning of September 9, 1958, some of Tristan's inhabitants were out on the slopes of the island's long-dead volcano, tending their potato patches. One of them was G. Francis Harris, who also happened to be the official administrator of the island, officially appointed by the Foreign Office back in London. Suddenly, Harris and his fellow islanders glanced up from their planting, distracted by an unusual phenomenon in those parts: the sound of airplane engines.

Two planes with US Navy markings swept overhead, low enough that the pilots could be seen peering curiously below. The friendly islanders tried waving to them, but the planes responded by abruptly turning back out to sea. "This was thought odd and most unfriendly," Harris later recounted, particularly since "the islanders had not seen an aeroplane for 15 years, apart from a helicopter, and so they were most surprised."

Harris instructed the island's radio operator to try to pick up any unusual signals that might help to figure out what was going on. He found the airwaves alive with enigmatic coded transmissions, but attempts to contact the senders were ignored. "All was in code, but we were able to advise the

Royal Navy in South Africa about unusual activity, and quote to them the call signs of three or four American destroyers," Harris said. From his account, the islanders were rather put out by the experience. It caused "a good deal of consternation," he noted. "We were never told why they should have been in our area without telling us, or why they appeared so unfriendly, or why they did not pay us a social call!" he complained.[1]

Not until almost two years later, in July 1960, would Harris and the other residents of Tristan da Cunha find out the answers, when *New York Times* science reporter Walter Sullivan thought to contact them to ask if they'd happened to notice anything odd going on back in summer 1958. Barely two weeks before the decidedly antisocial US Navy airplanes buzzed the ancient volcanic island, in the depths of a cold and stormy South Atlantic midnight at the end of August 1958, an atomic bomb had been detonated about sixty miles south and three hundred miles above Tristan. Over the ensuing fortnight, two more burst in the night sky, the last only two days before Tristan da Cunha's aerial flyby.

The islanders had enjoyed front row seats for what was then the most secret Cold War operation in the world, a massive undertaking that would later be revealed to the public as "the greatest scientific experiment of all time."

And they had slept through the whole thing.

CHAPTER 1

The Panic of 1958

ON OCTOBER 4, 1957, THE 187-POUND BEACH BALL–SIZED GADGET NAMED Sputnik was launched from the steppes of Kazakhstan in the Soviet Union, announcing its presence to the world with a steady radio beeping as it circled the planet every ninety minutes. Everyone who heard it—or learned about it from the torrent of hysterical news reports—knew immediately that nothing would ever be the same.

It wasn't that the *idea* of an Earth-orbiting satellite was such a big deal. Scientists had been talking about it for years, and, in fact, both the United States and the Soviet Union had announced plans to do just such a thing as part of the newly begun International Geophysical Year (IGY), a coordinated eighteen-month program of research and exploration by more than sixty nations, dedicated to achieving a greater understanding of planet Earth. America had two separate but equally driven teams working on its satellite program: one called Vanguard, operated by the Naval Research Laboratory and strictly devoted to the civilian science ideals of the IGY, and another under the decidedly more martial auspices of the Army Ballistic Missile Agency (ABMA), led by Major General John Medaris and expatriate former-Nazi rocketeer Wernher von Braun.

Both groups had been engaging in a spirited competition to earn the official nod from the White House to launch what was then expected to be humanity's first satellite. But interservice rivalry, political maneuvering, and Cold War concerns had hampered progress. The Army—which had been steadily working on developing missiles since its postwar experiments with von Braun's captured V-2 rockets—had a definite technical lead, but the Vanguard group had a stronger civilian pedigree, which better meshed with President Eisenhower's desire to keep America's IGY and space research efforts free of any militaristic bent. For that reason, Vanguard was to be the first to make the attempt.

Everyone liked to believe that the Soviet Union was far behind the United

States in science and technology. Yes, they also had atomic and hydrogen bombs, but it had taken them years to catch up, and besides, they had cheated, relying on espionage to steal American secrets. The Soviets boasted about their prowess and might, but it was all bluster. There was simply no way that such a backwards society could best the United States in the accomplishment of a technological feat that no one had ever done before.

Except now they had done it. If anyone doubted the official announcement on Moscow Radio that was being repeated and spread across the planet, they had only to tune a shortwave radio to 20 MHz. *Beep beep beep*. It was there, it was real, it was passing over the United States, and there was absolutely nothing that anyone could do about it.

Including, it seemed, ignore it. Immediate reactions ranged from fear and anger, to excitement and scientific curiosity, to outright indifference and incomprehension.

For General Medaris, at the time hosting a reception for Washington dignitaries at ABMA headquarters in Huntsville, Alabama, there was only one natural response when his public affairs officer interrupted the party to announce the news. “Those damn bastards!” Medaris snarled. The way he said it, no one knew whether he was talking about the Russians, his Vanguard rivals, or the administration officials who had refused to give him free rein. His team could have launched a satellite at least a year earlier if they’d only been allowed, or so he told his guest, newly-designated-but-not-yet-confirmed Secretary of Defense Neil McElroy. A frustrated von Braun picked up on the theme, promising McElroy that his people already had the “hardware on the shelf” to put up an American satellite in sixty days or less, if Ike would just give them the green light.

Thousands of miles away from Alabama, physicist James Van Allen took the news with a far greater degree of scientific equanimity. One of America’s leading geophysicists and a driving force behind the IGY, he was aboard the USS *Glacier*, a research ship several hundred miles off the Galapagos Islands in the Pacific Ocean and en route to Antarctica when Sputnik launched. Van Allen was on the journey to launch “rockoons”—rockets lofted to high altitudes by balloons—to study cosmic ray patterns as part of the IGY. Earlier that day, he had sent off his first rockoon of the voyage.

He was busily writing up a brief summary of the day’s launch when an assistant interrupted with word of Sputnik. Immediately Van Allen headed for the *Glacier*’s radio shack to confirm the news and attempt to hear the sound of Sputnik for himself. It was there, loud and clear. But a mere radio signal didn’t necessarily confirm a satellite in orbit.

Ever the scientist, Van Allen proceeded to find out everything he could. He jury-rigged a paper tape recorder to chart Sputnik’s signals for analysis and to measure the Doppler shifts in the signal, which would confirm that the signal was coming from a moving radio source in orbit. Everything checked out: the *beep-beep-beep* was definitely from an orbiting satellite at precisely the altitude the Soviets had announced.

After gathering as much data as possible with the equipment on hand, Van Allen sat down to write a detailed seventeen-page report, including calculations of Sputnik’s probable orbit and other particulars. “Brilliant achievement!” he wrote. He added some personal observations, noting how politically-motivated delays in the US program had allowed the Soviets to trump the free world and wondering how the Russian achievement would affect the American effort. He praised the Russians’ “astute” choice of 20 MHz for Sputnik’s heralding frequency, observing that unlike the 108 MHz chosen for Vanguard, Sputnik’s voice was readily audible not only to amateur radio operators but anyone else with a receiver that could operate at that frequency.

“Where do we stand now on Vanguard?” he scribbled in his notes, adding, “Russians have a very great scientific lead on us.”[1]

IN HISTORICAL RETROSPECT, IT’S NOW CLEAR THAT FAR FROM BEING AN EVENT THAT immediately awed and terrified the world, the initial waves of Sputnik shock and hysteria didn’t rack the general public so much as they did the military and political powers that be. As science historian Sharon Weinberger notes, “there was no collective panic in the first few days following the launch. It was not immediately clear—except to a small group of scientists and policy makers—why the satellite was so important … for most Americans, the beeping beach ball initially produced a collective shrug.”[2]

Barely a month after the launch, the political posturing, bureaucratic finger-pointing, and editorial second-guessing had mostly settled down to a level only a few decibels above the usual omnipresent murmur of Cold War paranoia and apocalyptic anxiety. It helped that by October 26, the ceaseless beeping of the Soviet satellite had finally faded and passed into blessed silence. The damned thing was still up there, of course, and could still be seen passing regularly through the skies of the US on every dark, clear evening, but at least it wasn’t mocking us with its radio signal anymore.

There was no denying the fact that the Soviets had beaten us fair and square, but now they’d had their fun, and it was America’s turn. Soon now, Vanguard would be launched, and it would do more than just beep at the inhabitants of the planet below. It would carry actual scientific instruments that would conduct valuable research. Let the Soviets boast about Sputnik and their rockets all they liked—in the end, all they had done was pull off an impressive but ultimately pointless stunt. The United States, on the other hand, would begin the true exploration of space with Vanguard, paving the way for human beings to follow in the very near future.

But the Soviets were not about to wait. On November 3, 1957, they launched Sputnik 2. And this was not merely a carbon copy of its predecessor. It was almost a thousand pounds heavier, and also carried a living creature: a specially trained mixed-breed female dog named Laika.

Now, not only to many within the government and the military but to the American public, it was more than clear: the first Sputnik had not been a fluke, a lucky shot, a gimmick. The USSR had a real and substantial head start, and they were not going to be shy about flaunting it. Never mind the fact that they had now put a living thing in space, with all that portended for Russian intentions and capabilities for eventually sending human beings up there. With the first satellite, one could console oneself with the fact that, impressive and ominous as it was, the thing was still less than two hundred pounds—far lighter and smaller than any practical nuclear warhead the Soviets might decide to lob at us. But Laika’s vehicle was far larger, an indication that they were getting into the realm of serious “throw-weight,” as missile designers referred to ICBM payload capacity. By contrast, the Vanguard satellite, in the midst of frantic launch preparations, weighed barely over three pounds, and was small enough to be held in one hand.

As capitalist animal lovers around the world bemoaned the fate of Laika and pestered the Soviet Union with accusations of animal cruelty when it became clear that she wouldn’t be coming home alive, others worried about the survival of the free world. Once more, questions abounded as to how Soviet Russia, a society in which washing machines and refrigerators were unheard-of luxuries, could have bested the most advanced country on Earth.

Obviously, many thought, it had to be due to more than the reasons offered by television commentators and newspaper editorialists. Even if it were true that Americans had allowed themselves to grow lazy and complacent, giddy with fancy tail-finned cars, silly TV shows, and rock-and-roll music, that couldn't explain everything. Had Communist spies stolen American secrets again, just as they had with the atomic bomb?

The only problem with that premise, aside from the lack of any actual evidence of foreign espionage in the missile program, was that if Soviet spies had stolen American technological know-how to build the Sputniks, then why hadn't America already launched their own satellites? After all, even though it was established fact that Russian spies such as the Rosenbergs had contributed to the USSR's atomic program, they had been relaying progress America had already made. As John Campbell, Jr., editor of *Astounding Science Fiction* magazine, observed: "Those Russian spies must be really good. They stole a secret we didn't even have yet."[3]

If not espionage, then, what was the explanation for Russian superiority? Why were we struggling to put an aluminum grapefruit into orbit while our mortal enemies were flying car-sized spacecraft over our country? Maybe it was simply because they knew something we didn't, some mysterious secret, a formula, a gadget that for whatever reasons of fate and chance, the United States did not have.

Physicist Herbert F. York, who had already been working for several years on nuclear weapons research and was about to become swept up in the official furor over Sputnik, wrote in his memoirs: "Many people, including some scientists and engineers who should have known better, came to believe that the Soviets knew some 'secret' about rocket propulsion that still eluded us, and even that Russian science in general was about to surpass American science."[4] Although that was decidedly paranoid, what was true, York and others came to realize after the initial Sputnik shock had faded and a more rational, if not always calmer, perspective began to take hold, was that the American missile and space program simply needed more time. The Russians had succeeded first not only because they'd been working longer and harder but also because their highly centralized, dictatorial system wasn't plagued with all the interservice rivalry, competition, duplication of effort, and plain old inefficiency of good old American democracy.

Things really weren't half as bleak as they seemed. Our civilian space program and our various classified defense efforts were proceeding apace, and all would work out in due course. Yes, we had to redouble our efforts and our determination, but there was no need to panic.

The problem was that such confidence arose from a privileged awareness based on classified data unknown to the public and the press. President Eisenhower realized that something had to be done to address American fears and to reassure people that however dire the situation seemed, the end was not near. On November 7, four days after Laika went into space, Ike went on national television to address his agitated constituents and to defuse criticisms that he wasn't doing enough to deal with this whole Sputnik situation. He announced the appointment of MIT president James Killian as the first White House science advisor, described a slew of new American weapons systems able to bring "near annihilation to … any country," and showed off the nose cone of a Jupiter C missile that had just been flown into space—on a suborbital flight—a few days before. "With two Sputniks in orbit, this display of a suborbital souvenir at the president's feet in the Oval Office was hardly reassuring," Paul Dickson wrote.[5]

Eisenhower's speech, and several similar ones that followed, did little to quell public anxiety. Polls showed that many Americans were convinced that the Soviets now had the ability to rain atomic warheads down upon our cities on a whim. But at least Ike was doing something. Perhaps most importantly, the day after his speech, he gave von Braun and Medaris official permission to launch their Explorer 1 satellite on the Army's Jupiter C missile as soon as possible.

First, however, would come Vanguard. On December 6, 1957, after two days of delays, America's first prospective spacecraft barely lifted off the pad at Cape Canaveral before falling back, the booster rocket exploding in a huge fireball. Unlike the previous Soviet efforts, which weren't made public until already successful, this humiliation took place in full view of the world on live television.

Even before the debris had been cleared and the Vanguard satellite was recovered from the tall Florida grass into which it had rolled after falling from the top of its rocket, the hand-wringing, finger-pointing, and pronouncements of impending doom began anew. Senator Lyndon B. Johnson presided over congressional hearings in search of an official scapegoat, while in the next couple of weeks, just in case anyone had missed the point that America was in grave danger, a top-secret White House report was leaked to the press that spelled out that message in dire detail.

Informally, it was called the Gaither Report, although its official title was suitably ominous: *Deterrence and Survival in the Nuclear Age*. The fruit of a months-long study commissioned by the National Security Council to examine defense preparedness against the Soviet threat and propose solutions, it was never supposed to be seen by the public. The commission was chaired by the head of the Ford Foundation, Rowan Gaither, and composed of various eminent citizens and defense experts, including members of the RAND Corporation, a think tank created to advise the Air Force.

The Commission’s report minced no words. America was not only in danger, she was facing the greatest threat in her history. Not only had we no defense against Soviet ICBMs, our own efforts in that department were woefully inadequate. The USSR was building far more missiles and bombers than the US, leading to an inevitable and dangerous “gap” in the coming years, and while they had shelters to protect their people from bombs and fallout, the US had practically none. The solution was obvious: immediately increase the defense budget by $44 billion over the next five years to start building more and better bombs, ICBMs, aircraft, and fallout shelters.

This was hardly the sort of thing that the ever-frugal Eisenhower wanted to hear, nor did he, as ex–Supreme Commander of all Allied military forces in Europe, think it necessary or advisable. But he faced a dilemma. Even as bits and pieces of the Gaither Report leaked to an eager press corps, Ike had hard evidence that matters were not nearly as dire as the Commission, LBJ, or the more alarmist members of the military establishment (particularly Strategic Air Command leader General Curtis LeMay) were declaring. The top-secret U-2 spy plane, which had been conducting aerial reconnaissance over the Soviet Union since 1956, had produced photos that proved conclusively that the Russians were not in fact turning out atomic missiles or bombers like sausages, as some, including Soviet leader Nikita Khrushchev himself, had claimed. In fact, it was quite the opposite. The Russians’ missiles might be making more impressive headlines than the Americans’, but we definitely had more of them, not to mention bomber aircraft and nuclear weapons of all kinds.

But Eisenhower knew that revealing those facts also meant revealing how they were acquired. And that meant giving up an enormous and very real strategic and psychological advantage. The Soviets certainly knew about the U-2—they routinely tracked its intrusions into their airspace—but, so far at least, they had been unable to do anything about it, which made them just as keen on keeping its existence from the public as the Americans. It amounted to a sort of Cold War “gentlemen’s agreement” to keep the secret for mutual benefit. Public disclosure of the U-2 would force public protest by the Soviets and inescapable demands to stop the over-flights, thus eliminating the US’s most valuable source of intelligence.

Eisenhower was forced to endure withering contempt and criticism from all sides: the press, the public, the Democrats—even many from his own party and administration described him as a wishy-washy, spineless president who cared more about his golf game than protecting the United States from a grave threat. Despite enormous pressures, he resisted the calls to officially declassify the Gaither report, knowing it would only make the entire situation worse and do no conceivable good.

The president bided his time, secure in the privileged knowledge that the U-2 had given him, confident that the United States was not in any imminent danger but was instead about to regain its bearings. He took comfort from the poet Robert Frost, who gave the president a book of his poems, inscribed with a personal note: “The strong say nothing until they see.”[6]

BARRING AN ACTUAL ATTACK BY THE APPARENTLY MIGHTY SOVIET UNION UPON the humbled United States, it was hard to see how 1958 could possibly be any worse than the last few months of 1957. A deep gloom hung over the country regarding America’s place in the world. There was a generous helping of pessimism about the possibility of redemption, along with good old-fashioned fear and paranoia.

Toward the end of January, that almost palpable yearning for good news, for something to celebrate, focused on the Jupiter C missile and the payload it would carry into space: the Explorer 1 satellite. Still licking their wounds from their explosive December fiasco, the Vanguard team had made several more attempts to launch, all of which had failed. So the weight of all America’s hopes now fell squarely upon the shoulders of the unlikely odd couple of General Medaris and Wernher von Braun.

After two agonizing delays due to weather conditions at Cape Canaveral, Explorer 1 finally made it into space on the night of January 31, 1958. A little less than two hours later, after prodigious amounts of coffee and many cigarettes smoked by anxious technicians, scientists, and generals, it was confirmed: Explorer 1 was in orbit around the Earth. The United States finally had its satellite.

In the relief and jubilation that followed, no one paid too much attention to the fact that Explorer was really a rather puny thing, just over six feet long and weighing barely thirty pounds, small enough for three men to hoist over their heads, as Wernher von Braun, James Van Allen, and Jet Propulsion Laboratory director William Pickering did with a model at a February 1 press conference in Washington. The significant part wasn't the weight or size, emphasized the scientists—it was the instrument package. Designed and built by Van Allen, Explorer's instruments included cosmic ray and micrometeorite detectors and sensors to record temperature variations in the space environment. America's first satellite was far more than just a grandiose stunt, more than just a radio beacon or a dog carrier, like the Sputniks. It was instead a real scientific achievement.

However, the true extent of that achievement wouldn't become clear until several months later, long after the initial euphoria had faded. The more Van Allen, his graduate students, and their scientific colleagues pored over the results returned by Explorer 1, the more head-scratching ensued. At first, the cosmic ray detector seemed to confirm the data that Van Allen had collected in his many rocket and balloon tests over the previous years. Yet other data seemed to indicate no cosmic rays or other radiation count at all, which couldn't be the case. Was there some kind of malfunction in Explorer 1's radiation detectors? It seemed unlikely, not only because Van Allen's team was perhaps the most experienced in the world at designing such instruments, but also because they had purposely built the package to very conservative limits to allow for the unknown rigors of the orbital environment and stresses of space travel.

The next mission, Explorer 2, failed to go into space, but Explorer 3, which achieved orbit on March 26, cleared up the mystery. Van Allen and his team spent weeks analyzing the findings from both satellite packages, and on May 1 finally announced their conclusions to the world at a joint meeting of the National Academy of Sciences and the American Physical Society in Washington, DC. The Explorer satellites had discovered bands of radiation surrounding the Earth, trapped by the planet's natural magnetic fields. Not long after, the term “Van Allen radiation belts” caught on, and Van Allen found himself immortalized as a scientific pioneer. It was humanity's first scientific discovery of the new space age.

JAMES VAN ALLEN DIDN'T FIND OUT ABOUT IT UNTIL HE WAS IN THE MIDST OF analyzing Explorer 3 data, but someone else had already been speculating about the possibility of radiation belts surrounding the Earth.

At the University of California's Livermore Radiation Laboratory, a Greek-American physicist named Nicholas Christofilos had reacted quite differently to Sputnik on that fateful Friday evening the previous October. Christofilos wasn't worried about any scientific advantage the USSR might have over the United States, or about losing prestige in the IGY program. His concerns were far more direct and elemental.

It wasn't the satellite that mattered, he realized, nor the presence of the first artificial body in orbit, not even the incessant *beep-beep-beep* it emitted—even if those beeps contained some hidden nefarious messages, as some paranoid types were claiming. Apparently the satellite didn't even have scientific instrumentation, so any data it could provide would be minimal.

Before the Gaither report sounded the alarm about American vulnerability to the public, before Senator Johnson began his hearings, Christofilos had already recognized the most important fact about Sputnik: the R-7 rocket that had hurled it into space. It proved that the Soviets now had missiles powerful enough to loft objects at least hundreds of pounds in weight to vast heights and distances—and that those missiles worked.

On a peaceful October evening, a Soviet rocket had carried a harmless metal sphere bearing a couple of radio transmitters into space. On another evening in the near future, Christofilos knew, that same type of rocket—or more powerful ones the Soviets were no doubt developing or already possessed—could hurl a hydrogen warhead over the North Pole and down onto the United States. And, just as there was nothing that could be done about Sputnik except to tune in to its beeps, there would be no way to ward off Soviet warheads from devastating American cities. It was impossible to shoot down or otherwise intercept missiles traveling at thousands of miles an hour.

But, he mused, perhaps there was another solution.

Christofilos's main project, not to mention personal obsession, at Livermore was his concept for a nuclear fusion reactor called Astron. It was wildly original, revolutionary, and extremely difficult to realize on any practical level, just the sort of idea for which he had become notorious among his colleagues. Astron was strictly a civilian project—Christofilos wasn't directly involved with defense work or building weapons. But now that Sputnik had convinced him that the Soviets might be about to overwhelm us with their strength and apparently superior rocket technology, he extended his

Astron ideas into a possible means to defend the United States.

In the midst of the post-Sputnik upheavals in late 1957, Christofilos went to his supervisor at Livermore, Herbert York, and laid out his idea. The thermonuclear reactions at the heart of Astron involved confining superheated plasma in a magnetic field generated by circulating electrons. He proposed to simply expand and extrapolate that idea from the small to the large, involving the entire Earth. What if a vast number of high-energy electrons could be generated above the Earth's atmosphere?

He theorized that the planet's magnetic fields would shape and focus them into an intense field or shell of radiation strong enough to disrupt and perhaps even destroy missiles and atomic warheads passing through it. The electrons, Christofilos explained, would be generated by detonating nuclear weapons in space. He had a name for the plan: Argus.

Not incidentally, there was a potential side bonus for Christofilos. The Astron machine did not yet exist; the Earth did. If Argus was successful and proved his theory, it could also help to vindicate Astron.

"His purpose was of epic proportions," York later recalled. "He intended nothing less than to place an impenetrable shield of high-energy electrons over our heads, a shield that would destroy any nuclear warhead that might be sent against us … Nick was completely confident that he had found the answer to the new Soviet threat, and he was eager to work it out before it was too late."[7]

York was intrigued but dubious. Not only was Argus an idea on a "grand scale," but realizing it even on an experimental level would involve satellites —something that, at least so far, the US didn't have. And even if it could be organized, it was beyond the purview of Livermore or any other existing government agency. "There was simply no place to take an invention like Nick's," said York.

But that was not going to stop Christofilos. He set out campaigning for Argus over the following months, first at the lower levels of officialdom in government and the military, and then moving steadily up the ladder. His urgent advocacy and untiring persuasiveness soon won him a growing legion of converts among Sputnik-spooked bureaucrats and military men, up to and including members of the brand-new President's Science Advisory Committee. When Secretary of Defense Neil McElroy established the Advanced Research Projects Agency (ARPA) of the Department of Defense in early 1958 as an official response to Sputnik, Christofilos finally had a place to take Argus—a place that would soon be equipped with a convenient ally when York was named the chief scientist of ARPA.

On January 10, 1958, Christofilos spelled out his proposal in detail in the highly classified paper “On the Possibility of Establishing a Plasma Shield of Relativistic Electrons in the Exosphere of the Earth as a Defense against Ballistic Missiles,” a title that made his ambitions abundantly clear even to those who didn’t bother to read the technical details.[8] The paper was widely circulated amongst the upper echelons of secret military and governmental circles, piquing intense interest and much discussion.

Christofilos didn’t know it yet, but some people were already taking him very, very seriously. Just over a month before, on the second and third of December, Pentagon scientist Frank Shelton had briefed CIA officials on “the Christofilos concept,” warning them specifically “to watch for similar Argus developments in Russia.”[9] If we could think of it, so could they, was the implication. As bad as Sputnik might have been, that would be even worse.

Classified discussions continued and intensified, as anything and everything Argus-related was placed under the deepest secrecy. ARPA and the Armed Forces Special Weapons Project (AFSWP)—the Pentagon agency in charge of nuclear weapons for all the military services—set out to make preparations and plans for what Christofilos, with his characteristic self-confidence, called “the most fantastic experiment ever conducted by man.”

CHAPTER 2

The Elevator Repairman

BY THE LATE 1950S, WITH CONCEPTS SUCH AS ATOM BOMBS AND RADAR AND outer space now familiar touchstones in newspapers, magazines, radio, and the new medium of television, the image of The Atomic Scientist was firmly embedded in American culture. To a great extent, that image was based on the most famous scientist of them all, Albert Einstein, who had only recently died in April 1955.

Before World War II, the Victor Frankenstein/“mad scientist” stereotype tended to prevail in films, pulp magazines, and radio shows—figures sporting vague foreign accents, wild hair, and lab coats (or, if they were truly evil, elaborately designed leather costumes). But after the war, as the atomic bomb brought renewed prominence to Einstein and introduced new science stars such as J. Robert Oppenheimer, a gentler, more benign model took firm hold. One of its earliest manifestations in Cold War popular culture was Sam Jaffe’s portrayal of Dr. Jacob Barnhardt in the classic 1951 science fiction film *The Day the Earth Stood Still*. Quite consciously patterned after Einstein, Barnhardt is the film’s voice of scientific restraint and reason, the rational yin to Helen Benson’s (Patricia O’Neal) more emotional and empathetic yang of humanity, who together help alien visitor Klaatu navigate the paranoiac chaos of Earth society. Now that science had become so intertwined with government and the military, the few mad scientists who continued to lurk through 1950s pop culture were less Colin Clive’s Henry Frankenstein than Einstein—soft-spoken otherworldliness and all.

Nicholas Constantine Christofilos didn’t fit any of the popular scientist stereotypes. He tended more toward saggy blue serge suits, bright ties, and scuffed-up black shoes than the tattered sweaters of Einstein. Nor was he thin and ascetic; he was sturdy, and had an avid appetite for fine food and wine. Whereas Einstein was a famous pipe smoker, Christofilos preferred a steady stream of cigarettes. The accent was definitely there—a thick Greek variety that at times could be so heavy that some of his interlocutors wished he came accompanied by an interpreter. Calm and reserved he definitely was not. A colleague once remarked that Christofilos could easily play both roles in an argument between a pair of cab drivers.

But far more than appearance and temperament set Christofilos apart from his colleagues. His background was hardly that of the traditional academic.

He was born in Boston on December 16, 1916, the birthday of Ludwig van Beethoven, who would later become one of Christofilos's favorite composers. His parents were first-generation Greek immigrants who ran a popular coffeehouse called the Wellington Cafe, but eventually grew restless for the old country, and in 1923 moved back to Athens with their only child, seven-year-old Nicholas, in tow. While his father reestablished himself in the coffee shop business, a gadget-fascinated Nicholas began tinkering, taking apart radios and eventually learning how to build them himself, an interest partly inspired by his discovery of the novels of Jules Verne. He also displayed a passion for music, studying piano at the Athens Conservatory with the famed Greek concert pianist Gina Bachauer.

Yet it was science that truly pulled him in. By age twelve he had already proclaimed his intention to become an electrical engineer. He became a ham radio operator until forced to abandon the hobby when the Greek government banned amateur radio in 1936. But his engineering ambitions were realized with a degree in electrical and mechanical engineering from the National Technical University of Athens in 1938.

Christofilos was already thinking big. He planned to get an engineering job for a while, build up some experience, then return to the United States—and the city of his birth, Boston— to continue his education at the famous Massachusetts Institute of Technology. The job was no problem: he found a position at Wisk, Inc., a company specializing in installing and maintaining elevators. It was a good spot for someone with both mechanical and electrical talents, and there were certainly plenty of apartment and office buildings in Athens to keep Wisk in brisk business. Christofilos worked and planned for his return to America, spending his spare time reading textbooks in physics and the nascent field of nuclear science. Most of those books were in German, of course, since that was where most of the important work in those fields was being conducted by people such as Werner Heisenberg and Otto Frisch.

Unfortunately, Benito Mussolini, Adolf Hitler, and fate had other plans. In October 1940, Mussolini, drunk with hubris and a desire to grab some glory from his senior dictatorial rival in Germany, invaded Greece. The Greek army proceeded to repel the Italian forces and push them back into Albania, forcing Hitler to come to the rescue of his hapless ally six months later. The Nazis quickly occupied Greece, and Christofilos found himself under the heel of a new government.

It was definitely a blow to Christofilos's post-graduate ambitions, but an uninvited boost to his career in mechanical engineering. The puppet government installed by the Nazis nationalized Wisk, Inc., converting its function from fixing and installing elevators to repairing military vehicles. The twenty-four-year-old Christofilos was given the choice of promotion to a supervisory position or imprisonment as a potential saboteur—or a death sentence, if his intentions were deemed suspect. Christofilos took the promotion.

Despite the harsh realities of life under German occupation, Christofilos's new position was undemanding, and left him with a lot of free time, which he devoted to an even more dedicated program of self-education. If the Germans brought with them to Greece oppression, hatred, and senseless cruelty, they also brought along more of their hard-to-get scientific books, papers, and journals for an eager Christofilos to devour.

So for the remainder of the war, Christofilos led a rather mundane existence, or at least as mundane as possible under the circumstances. He spent his days at the shop, fixing Nazi trucks and riding herd on his mechanics, and his nights at home or in the library, poring over advanced texts in physics and mathematics, including some of the latest works out of Berlin: *An Introduction to Nuclear Physics* by Siegfried Fluegge, for example, published in 1942, or *Nuclear Physics Tables* by Joseph Mattauch. Christofilos was working on his own without the guidance of mentors or teachers to keep him on a more conventional and traditional pedagogical path, with nothing to keep him going save his own passionate enthusiasm for his subject and his natural predilection to follow odd ideas and invent his own ways to solve problems. Long before night school was even a thing, he was a self-styled night school student immersed in some of the most advanced, cutting-edge science of his age.

Particularly in light of later wartime developments, some of the titles of his reading material might give the impression that Christofilos was already thinking about atomic bombs. But he was not ruminating on uncontrolled, destructive nuclear power, but rather on tightly controlled energies in the service of scientific research. Back in the United States, physicist and Nobel Laureate Ernest Lawrence at the University of California at Berkeley had been building and using highly sophisticated particle accelerators since the previous decade, giant “atom smashers” that were probing the innermost secrets of the structure of matter. Christofilos was fascinated by such concepts, and was beginning to think of ways to improve upon and expand the capabilities of particle accelerators and cyclotrons—and eventually, design them himself.

By the time the occupation and finally the war ended, Christofilos was beginning to do just that, although still in his spare time. No longer a truck repairman, he returned to the elevator business, opening and operating his own company. Meanwhile, he was able to expand ever more widely the range of his scientific reading, now supplemented by visits to the United States Information Service in Athens, which provided access to important American journals such as *Physical Review*, which had been unavailable to him during the war.

His thoughts were still pointed squarely across the Atlantic to America. Before the war, the intellectual nexus of scientific research had been in Europe, but now America was on top of the world, not just politically, militarily, and economically, but scientifically as well. Most of the world’s top scientists lived there, from Einstein on down, and the United States also had both the most advanced research facilities on Earth and the money to operate them and build new ones. Christofilos’s restless mind was not going to be content with cornering the Athens elevator market by day while reading obscure physics books in the dead of night.

The problem was that because his circumstances and temperament had forced him to eschew the typical, accepted pathways to establishing himself in academic and scientific circles, he didn’t know anyone, and nobody knew him. He had no old friends from grad school with whom to discuss his ideas, no former teachers or mentors to call on for advice and counsel or job leads. If he was going to get back to the United States as a scientist, he would have to do it the hard way, making his own path as best he could. He might not be able to dazzle the scientific establishment with fancy degrees or powerful and influential friends, so he would do it through audacious inventiveness. Already deeply versed in the theory, if not the practice, of particle accelerators and their design and operation, he began to come up with ideas.

In 1946, Christofilos had already attempted to secure a patent for a new type of particle accelerator, but further reading and research in the scientific literature now available to him soon demonstrated that he'd missed that particular elevator: someone else had already invented the thing. The machine, known as a synchrotron, had been conceived separately by Russian scientist Vladimir Veksler and Edwin McMillan at Berkeley, who built the first working example in 1945. But as usual, Christofilos was not dissuaded, and set about devising ways to improve upon their designs.

Whatever the name of a particle accelerator, whether cyclotron, Betatron, or synchrotron, such machines all perform the same basic function: generating, focusing, and controlling beams of charged particles such as electrons or protons, which can then be made to collide with each other in ways that reveal their inner structure and generate new particles from the debris. To control and direct the nuclear particles, the machines use intense electromagnetic fields that not only require enormous amounts of electrical power to generate but also huge, unwieldy, and exceedingly expensive magnets, which is why such facilities tend to be industrial-scale in physical size and electrical power requirements.

Christofilos wanted to find some way of changing all that. In 1948, he began to send letters off to the premier particle accelerator facility in the world, Ernest Lawrence's Radiation Laboratory at the University of California at Berkeley. Surely, he reasoned, once the people at Berkeley had the chance to hear and consider his ideas, they would recognize their validity, not to mention the talents of the man proposing them.

The folks at the Lawrence lab already had some passing acquaintance with Christofilos, as he'd sent them a copy of his previous patent application, which he'd filed simultaneously in Greece and the United States. No one had been very impressed then, since he had been essentially reinventing the wheel. In the new postwar age of scientific discovery and public prominence, institutions and agencies such as Lawrence Laboratory, Los Alamos, the Air Force, the Atomic Energy Commission, various universities, and most other centers of learning and innovation, along with famous scientists such as Albert Einstein or J. Robert Oppenheimer, were routinely inundated by mail from people claiming to have made The Next Great Scientific Discovery That Will Change Everything. Dutiful secretaries filed such material away in "crackpot files" and moved on to more important matters.

Still, Christofilos's first letter managed to stand out from the rest, perhaps partly because, despite the odd mathematical approaches on display, it was clear that he seemed to have some degree of expertise. The Berkeley scientists passed it around to one another, more out of bemusement than serious interest, but no one was quite able to pin down just what Christofilos was talking about.

Finally, whether out of sympathy, a sense of politesse, or simple boredom, somebody decided to sit down and write out a response, setting out in detail the reasons why Christofilos's ideas, while certainly intriguing, were wrong. His design improvements wouldn't work, and this was why. But we greatly appreciate your interest and enthusiasm, and best of luck to you, and thanks for writing, etc.

Most people would be discouraged with such a response, but Nicholas Christofilos was not most people. He plunged even deeper into reading, calculating, and thinking, refining and perfecting his ideas. He was certain he was right, somehow, even if he didn't quite understand why yet. Armed only with his own abstruse mathematics and boundless enthusiasm for his subject, he devised an approach he dubbed the "strong focusing principle," a means of manipulating alternating magnetic fields inside a cyclotron to precisely control particle beams.

He was trying to solve a problem that had been plaguing the designers of particle accelerators from the beginning. Such machines basically come in two configurations: linear and ring-shaped (disregarding the type that uses static electric fields to shove particles around, such as Van de Graaff generators). Since particles (and anything else in motion, as Isaac Newton described) tend to travel in a straight line unless acted upon by an outside force, linear accelerators seem straightforward enough, being long and straight. But what about when the charged particle reaches the end of the line? It's not a problem if your intention is to make the particles hit some kind of target—the inside of a phosphorescent screen to make it glow, perhaps, or a cancerous tumor to destroy it.

On the other hand, if you want to keep your particles moving and accelerating to ever higher energies, then sending them endlessly turning around in a circle is the clear solution, as Ernest Lawrence realized when he created the first cyclotron in 1929. But there's the problem of Newtonian physics. Since speeding protons or electrons or atomic fragments naturally travel fast and straight, a means of getting them to stay in a circular path is needed. Cyclotrons use powerful magnets for that purpose, which work well but are also big, heavy, and expensive.

And there's another problem. It turns out that while controlling a beam of charged particles in one plane—horizontally, for example—is fairly straightforward, doing so in added dimensions at the same time—say, vertically—is far more complicated. In practical terms, you can control your beam in the x-axis or the y-axis, but not both at the same time, at least not at the extreme speeds and energies required to do valuable scientific work. Try to force a beam of charged particles too strongly in one direction off the straight and narrow, and it will keep attempting to veer off in the opposite direction, trying to satisfy Newton's first law. The only solution seemed to be ever bigger, more powerful magnets to make the particles behave as desired.

Over the next couple of years following his polite Berkeley brush-off, Christofilos sought to overcome this dilemma with a new approach. "Christofilos proved mathematically that the obvious ideal, simultaneously focusing the beam in both the x and y directions, is physically impossible," wrote Elisheva R. Coleman, Samuel A. Cohen, and Michael S. Mahoney in a 2011 history.[1] But, reasoned Christofilos, doing both alternately and very quickly would create a net effect that would achieve essentially the same result. And since such an approach, which boiled down to finessing the beam path instead of wrestling it into line with brute force, wouldn't require such powerful magnets, it had the practical benefit of reducing both the construction costs and the operating costs of a cyclotron. Christofilos called it strong focusing.

The normal course for the typical academic-type research scientist would have been to write it up into a detailed scientific paper, ideally after some practical experiments as proof-of-concept, and submit it to one of the leading journals in the field, such as *Physical Review*. But that was not the sort of option open to Christofilos, who lacked any notable academic credentials or a position at an established research university or scientific institution. Again, Christofilos instead took the more direct approach of applying for a patent, titling his March 10, 1950 application "Focussing System for Ions and Electrons." Perhaps out of optimism, perhaps out of spite, perhaps out of a combination of the two, he again sent copies of the application to Berkeley.

This time, the Radiation Laboratory was not as polite. Christofilos's missive was summarily dismissed and shunted away into "file and forget" oblivion, merely another dispatch from "that crazy Greek."[2] This correspondence seems to be the origin of this particular sobriquet, which would subsequently come to be inextricably linked with Christofilos, at first only in private and professional circles and then finally by the public and press at large. There is no record that Christofilos ever seemed to mind. As Edward Teller, another scientist famous for wild ideas, but one who enjoyed a considerably more exalted professional cachet, recalled later, "Because the mathematical method was different from practices of American physicists, the Californians did not examine the proposed focusing system in full detail."[3]

By this time, even Nicholas Christofilos was beginning to have second thoughts about his career choices. But back in the United States, other events were percolating that would soon intersect with and ultimately change Christofilos's life.

On the other side of the continent from Berkeley and Ernest Lawrence's Radiation Laboratory was Brookhaven National Laboratory in Long Island, New York, established in 1947 by the Atomic Energy Commission as a place to investigate and develop peaceful uses for atomic energy. Brookhaven quickly became the East Coast hub for advanced research in particle physics, its scientists and machines the chief rival to Berkeley. The Brookhaven team of Ernest D. Courant, M. Stanley Livingston, and Hartland S. Snyder had been working with a powerful synchrotron with the science-fictional name of "The Cosmotron." Quite independently and completely unaware of the work of the "crazy Greek" who had been plaguing their colleagues on the West Coast, they developed a concept for a new accelerator design using a technique called the alternating field gradient focusing principle—or in other words, strong focusing.

Following the well-defined procedure of fully-recognized academic/professional scientists, Courant, Livingston, and Snyder published their research in the *Physical Review* on December 1, 1952, under the title of "The Strong Focusing Synchroton - A New High Energy Accelerator."[4] It was, as far as anyone knew, the first time such an idea had been put forward in the scientific world, certainly in the standard literature. Nicholas Christofilos's patent application was still making its laborious way through the innards of the US Patent Office, while his previous letters detailing his ideas, complete with his wonky mathematics, remained buried and forgotten somewhere in the correspondence files of the Berkeley Radiation Lab.

And Christofilos himself—still in Athens and well out of the loop of the scientific establishment—remained blissfully unaware that anyone else, let alone a trio of American researchers in Long Island, New York, had just gotten the credit for the thoughts that he had painstakingly worked out through countless hours after long days installing elevators in office buildings and apartment complexes, all on his own and without the use of great multimillion-dollar research instruments staffed by technicians and graduate students.

But, even though he certainly didn't get the latest issues hot off the press from the US Information Service, he dutifully kept up with his reading. Which made it inevitable that sooner or later he would discover that he had been scientifically scooped.0

Sometime in late 1952, Christofilos learned of the Brookhaven research, though accounts differ on whether it was from gathering hints and rumors from pre-publication sources and gossip or from the actual *Physical Review* publication of the Courant, et al., paper. Whatever the case, he wasted no time in taking action. The concepts in the Brookhaven paper were essentially the same as those he'd earlier proposed to Berkeley in his follow-up missives after his initial letter had been gently rejected and corrected. He knew that different scientists working independently often came up with the same basic ideas; that was how science and invention had always worked. After all, other people had thought of the electric light, the telephone, the airplane, evolution by natural selection, and various other ideas long before Edison, Bell, the Wright Brothers, or Charles Darwin came along. But the names history remembered were the people who had stayed with their ideas, developed them, fought for their acceptance. And in his own way, Christofilos had been doing likewise. Maybe he hadn't published in a major (or even a minor) scientific journal, but he had a patent pending on strong focusing.

He engaged a big Greek law firm with connections and offices in Washington, and with some advance money from them, set out to return to America to investigate and stake his proper claim. In January 1953, he arrived in New York, went to the New York Public Library to read further on the Brookhaven paper and related work, then headed out on Long Island to confront his as-yet-unknowing rivals. He told them of his work in detail, explaining how the *Physical Review* paper had essentially laid out what he'd already presented to the Berkeley Radiation Lab, and how those good folks had summarily dismissed him. He wasn't necessarily accusing anyone of stealing his ideas—he knew all about coincidence and simultaneous discoveries—but given his primacy of interest, shouldn’t he at least get some substantial acknowledgment?

This was not the way that scientists generally received recognition for their work.

The Brookhaven people were suitably chagrined and not a little surprised. Normally, this argumentative Greek might have been dismissed as just another crackpot, but if there was a legitimate patent application involved, they couldn’t afford to ignore the situation. They promptly got in touch with their Berkeley colleagues to check into Christofilos’s tales of woe and scientific one-upmanship.

“Retrieving his manuscript from the file, red-faced Berkeley scientists saw that while the details of his scheme differed from those of the Brookhaven scientists, the principle was the same,” wrote historian Robert P. Crease.[5] They, as well as the Brookhaven group, gracefully acknowledged that Christofilos deserved the primary credit for coming up with the strong focusing idea. After consultations with Christofilos’s lawyers and the Patent Office, the Atomic Energy Commission agreed. Finally, Nicholas Christofilos had been recognized as a serious, authentic, and creative scientist, and all without a fancy Ph.D. His conception of strong focusing was officially acknowledged in a letter published later that year in *Physical Review*.

Not that everyone was really happy about it. Crease quotes a peeved Brookhaven accelerator scientist, Kenneth Green, who later wrote to a colleague: “When it turned up that [Christofilos] had independently conceived the strong-focusing idea, we were intrigued and impressed. However, his mathematical work … was less advanced, and his calculations were scarcely suitable for the design of an operating machine … The time had become ripe for the invention of strong-focusing and it was inevitable that someone would happen upon it. To be historically correct, the principle was really laid down in a paper by Thomas in 1938.”[6] It is unknown whether the paper of which Green speaks was a part of Christofilos’s voluminous self-education in the years before, but whatever the case, in this particular instance his diligence, imagination, unconventional approach, and most of all his foresight to file for a patent had paid off handsomely.

And not just in prestige, but financially. Following negotiations among Christofilos’s lawyers, the AEC, and the Brookhaven Laboratory, Christofilos was granted a $10,000 licensing fee to allow Brookhaven the right to use strong focusing techniques in their new accelerator. The prestige factor turned out to be even more valuable than the money, however. It was now undeniably clear that here was a brilliant and inventive scientist who was far too valuable to be allowed to languish in Athens fixing elevators.

As usual, he was bursting with ideas, most of them now dealing with harnessing the power of nuclear fusion for peaceful purposes after the first hydrogen bomb had been detonated by the United States less than a year earlier. The United States was already putting together a fusion reactor program dubbed Project Sherwood, and Christofilos presented his own concepts at an early meeting of project personnel in April. “He made his presentation with the unbridled energy that would always characterize him—voice raised, arms flailing with the force of his gestures, wild scribbling engulfing the blackboard,” described Coleman.[7] The assembled physicists were suitably enthralled by the performance—and the ideas. Christofilos’s Astron proposals “seemed to combine the best features of the rival existing approaches to fusion … and therefore was something they wanted to pursue.”

There was, however, a problem. Research in fusion reactors, even if it had little to do with fusion weapons, was still highly classified, and Christofilos had no security clearance. Even during his Astron presentation to the Project Sherwood crew, this issue had caused some consternation when, running out of blackboard space to scribble his equations, Christofilos had moved the board aside to find another board underneath covered in classified data which he wasn’t supposed to see.

To some people, this eccentric figure was already suspicious. Herbert York recalled, “The security people had their doubts. They found it hard to believe that ‘an elevator mechanic’ had accomplished all that Nick [Christofilos] claimed. He must be, they thought, some kind of mole that the Russians, who also knew about accelerator technology, had pumped full of ideas not his own.”[8]

Whatever the case, it was obvious that Christofilos was somebody that should be working on the fusion project, but getting him security clearance would take a while. What to do with him in the meantime? Fortunately, Brookhaven had already gotten over its feelings of chagrin at being upstaged, and offered Christofilos a staff position to work on their new accelerator. Meanwhile, he could continue to develop his Astron theories and calculations, then pick up with serious fusion work back in California after his security clearance came through. He enthusiastically accepted, beginning work at Brookhaven in June 1953.

It seemed like an excellent plan. Christofilos would delve into fascinating, practical work at Brookhaven on accelerators and particle physics, the sort of stuff he'd been doing only in theory back in Greece, while still continuing to work on Astron and any other ideas that arose from the depths of his imagination. Then he would move into the secret, classified world, working not on weapons but on a source of energy that could transform the planet. He would never again install another elevator.

And he was back in the United States at last, but this time to stay. He loved Greece, the home of his parents and ancestors and the place where he had spent most of his life up until now, but ultimately he considered himself an American. He had never stopped being an American citizen and to him, the United States, not Greece, was truly his country. Now he would be able to use his gifts to serve that country and her people.

As he settled into Brookhaven, Christofilos also settled into a new life. In spring 1954, his Greek girlfriend, Elly, arrived in the US, and they married on April 27. Although Christofilos was in his element, finally working at the forefront of his chosen field, Elly did not take well to life in America, a problem to which her husband seemed to pay little attention. It was an oversight he would eventually live to regret.

But for the time being, all was well, and Christofilos would become a vital member of the Brookhaven team for the next three years. In 1956, his security clearance finally came through, and Nicholas Christofilos was deemed loyal enough by his native country to be entrusted with its vital secrets.

Now he could truly get down to business. America's fusion energy research was centered in California at the Lawrence Radiation Laboratory, which had spun off from the Berkeley Radiation Lab, mostly for the purpose of developing nuclear weapons in competition with the Los Alamos Laboratory, which had created the world's first atomic bombs. In December 1956, Christofilos, Elly, and their baby son, Nicholas Jr., left New York for California. For Elly, it was another disrupting, upsetting change of environment and lifestyle. For Nicholas Christofilos, it was an entry into a heady realm of secret science, political intrigue, and the chance to determine the future of not only his country but the entire planet.

CHAPTER 3

Lines of Force

BY THE TIME AN AGITATED NICHOLAS CHRISTOFILOS FIRST BURST INTO HERBERT York's office with the idea for Argus, America had been in the atomic testing business for quite a while. Ever since the first atomic explosion on July 16, 1945, the United States had detonated close to a hundred nuclear devices. Many of them had been in the continental United States, first in New Mexico, then at the Atomic Energy Commission's Nevada Test Site beginning on January 27, 1951. Many other more powerful weapons, including a number of hydrogen bombs, had been tested at the Pacific Proving Grounds, where the US made use of islands captured from the Japanese in World War II. And two had exploded over Japan in August 1945, killing and maiming hundreds of thousands of human beings.

In 1957 alone, before Sputnik unleashed a different kind of explosion within the scientific community, the United States had tested twenty-nine atomic bombs, all in Nevada. Plans were underway to test more hydrogen weapons in the coming year in the Pacific, even as concerns about atomic fallout and worldwide protests were forcing reluctant national leaders to contemplate a testing moratorium.

The tests conducted by the AEC were of a dizzying variety. To most average folk, a Bomb was a Bomb, but the weaponeers of Los Alamos and Livermore, not to mention the Pentagon strategists who devised the ways and means to use them, knew better. Nukes came in all physical sizes and levels of explosive power, from small weapons that could fit in the back of a truck, shells that could be fired by artillery pieces, and huge, monstrous devices that weighed tons and could be carried only by airplanes or ships. Atomic weapons could wipe out soldiers on the battlefield, a flotilla of ships or submarines, an air or naval base, or an entire metropolitan area, including the suburbs. Explosive yields ranged from a mere few hundred tons of TNT to multimillions.

But wherever the weapons were tested, whatever their design, all the tests had been conducted with one of three main objectives: trying out a new weapons design; studying the immediate effects of the nuclear explosion on buildings, bridges, animals, materials, or people (psychologically if not physically); or devising military tactics for their use in warfare. The test series and individual "shots" (atomic detonations) were given odd, nonsensical code names such as GREENHOUSE or TUMBLER-SNAPPER or UPSHOT-KNOTHOLE[1], and were complex logistical undertakings that took a year, usually more, to organize, and involved thousands of people, from scientists, military brass, and governmental administrators at the top all the way down to construction workers, technicians, and enlisted draftee soldiers at the bottom.

Testing Christofilos's ideas would be quite a different proposition. It would literally be a scientific experiment on a global scale, using the entire planet as both laboratory and test subject. It wouldn't require any special new weapons design—an off-the-shelf nuke would do fine, as long as it was detonated high enough in the atmosphere. The extreme altitude would ensure that any direct effects on people or things on the ground would be minimal if not nonexistent. As to the military utility of the entire enterprise—finding that out was essentially the whole point.

Though Christofilos wasn't aware of it at the time, military planners had already been thinking about high-altitude nuclear explosions. According to the official history of the Defense Nuclear Agency, Pentagon strategists worried about what might happen with nukes in outer space. "Christofilos' study was an extension of the DoD's [Department of Defense] interest in the effects of nuclear explosions in the outer atmosphere. In the early years of the missile age, military planners feared that electrons emitted by such large-altitude nuclear blasts could become trapped in the Earth's atmosphere and might possibly block the operation of ballistic missiles and defensive radar systems." A 1955 test series in Nevada, TEAPOT, had raised concerns about an electromagnetic pulse (EMP) generated by atomic weapons, and "there were numerous questions about the effects of missile-launched weapons and detonations in space, especially the effects of EMP on radio communications and equipment."[2] Now that the Soviet Union had made the missile age a dangerous reality, leaving America struggling to catch up, such questions were more urgent than ever.

The next big nuclear test series, dubbed HARDTACK and set for the

Pacific in the new year, included some high-altitude shots, but none high enough to test Christofilos's theories. And there was another wrinkle that Christofilos himself introduced soon after approaching York. "A week or so after Nick first opened the floodgates on this stream of new ideas, he came in with an addendum. He had made a new calculation that showed there is already a 'background' of electrons of natural origin trapped in the Earth's magnetosphere, and he said we had to measure it before we did any experiments with a bomb."[3] Otherwise, how could scientists possibly tell the artificially generated radiation apart from the natural background? It made sense to York, and fortunately James Van Allen and his colleagues at the State University of Iowa had already designed instruments capable of detecting electrons in space.

Unfortunately, of course, such instruments would have to actually be placed in orbit, something that the US had yet to accomplish. "Such devices were coming along, but we had not yet flown any," York noted. For the time being, at least, Christofilos would have to do something which went against the grain of his usual predilections: he would have to wait. Or so York counseled him.

He was not about to do that. Neither were other people, especially after Sputnik. Herbert Scoville, for one. As the Deputy Director for Science and Technology at the CIA, Scoville had read Christofilos's classified paper on Argus and was also aware of the concerns about high-altitude nuclear explosions. Thinking ahead to the near future when America would finally get its own satellites aloft, Scoville "worried that the Soviets might be thinking along the lines of Christofilos' paper and use a nuclear weapon to form a long-lasting trapped radiation belt and interfere with US satellites."[4] It might not be as apocalyptic a scenario as Christofilos's fears of incoming Soviet nuclear missiles, but it was far more likely, and something that the US would be helpless to counter.

The flipside of the coin, of course, would be that if the United States did it first, it could be a powerful weapon against the Soviets. Or perhaps a quasi-weapon, since it wouldn't involve any sort of direct military attack—which only made the whole idea more intriguing.

Anxious to get moving, and persistently prodded by Christofilos, York decided to go to the President's Science Advisory Committee, otherwise known as PSAC. Chaired by James R. Killian, PSAC authorized further study of Argus and its military potential. In early 1958, Christofilos got the chance to strut his stuff in a presentation of his Argus paper before the entire PSAC in Washington. “Christofilos presented, in his brilliant and vigorous way, his theories about the ‘Christofilos effect,’” Killian recalled. “By temperament effervescent, intense, and highly emotional, Nick could make any meeting explosive in discussion. [He] was in good form that day.”[5]

PSAC was duly impressed, both by Christofilos’s arguments and the other considerations that had already been circulating among Pentagon officials for months. They knew of the upcoming high-altitude HARDTACK shots, and that, while they might provide some interesting data, they wouldn’t conclusively settle the question of the widespread effects of such detonations. Argus promised to do so.

PSAC recommended that Christofilos’s theory be tested “as soon as possible.” The wheels were turning now. On March 6, Killian and Herbert York, now ARPA chief scientist at the Pentagon, briefed President Eisenhower, who approved undertaking further study in preparation for testing the Argus concept. He also approved the idea of launching a satellite to monitor the Argus effects.

An alphabet soup of governmental agencies were now involved. Aside from ARPA, Eisenhower instructed that efforts be coordinated among the Atomic Energy Commission (AEC); the Armed Forces Special Weapons Project (AFSWP), which was in charge of atomic weapons development across all the military branches; the Department of Defense (DOD); and of course the place where it had all started, Lawrence Livermore National Laboratory (LLNL), the defense-oriented offshoot of Ernest Lawrence’s University of California Radiation Laboratory (UCRL). Conferences, consultations, and secret meetings ensued in Washington, California, and elsewhere.

In the meantime, the United States had finally begun successfully launching satellites. At least, it had managed to put two of them into space, Explorers 1 and 2. Both of the satellites, and the upcoming Explorer 4, carried scientific instruments designed and built by James Van Allen, who, along with rocketeer Wernher von Braun, was suddenly a scientific superstar in the public eye.

Nicholas Christofilos’s own superstar charisma may have been hidden in the classified shadows, but it was of little concern to him. As long as he could focus on proving his theory and, in doing so, protect the United States, Christofilos was perfectly content to work away in the dark. If he had any frustrations about anonymity, he took them out on his piano at night, playing Beethoven and Bach, mostly all *fortissimo*, to the consternation of the neighbors. Meanwhile, he continued work on the Astron project.

On April 21, 1958, Killian and the White House received the official approval for the Argus operation from both the Secretary of Defense and the Atomic Energy Commission. Now it was solely up to one man to give the final go-ahead: the president. Killian promptly scheduled a meeting with Eisenhower on Thursday, May 1.

THAT SAME DAY, JAMES VAN ALLEN WAS IN WASHINGTON AT THE GREAT HALL of the National Academy of Sciences (NAS) for one of the biggest moments of his life. This one promised to surpass that crazy night only a few months past, when Explorer 1 became America’s first satellite in orbit. That had really been more von Braun’s and William Pickering’s triumph, since they’d been the men who put Explorer into space, while Van Allen’s instruments had just been along for the ride. (Von Braun would later make light of his celebrity status, telling Van Allen and his colleagues, “You’re the important ones. I’m just the trucker.”)[6]

But today, it was all about science and discovery in their purest forms. Van Allen and his team at the State University of Iowa (SUI) had spent the months since that January night collecting and analyzing the data from their instruments on Explorer 1, as well as its follow-up satellite Explorer 3. As required under the rules of the International Geophysical Year, under whose aegis the Explorers had been launched, Van Allen had reported his discoveries to IGY officials in April. Now the time had come to tell the rest of the world.

The session began promptly at 9:45 AM at a joint scientific conference of the NAS and the American Physical Society, with Van Allen reporting his findings to an amazed audience of colleagues, followed by a press conference at which Van Allen explained things in less esoteric terms for the benefit of reporters. One reporter asked for clarification, asking the scientist if the radiation he’d detected could be described as a “belt” encircling the Earth, and Van Allen agreed. The term “radiation belt” was born, to be further codified: “At a scientific conference in Europe soon after, NRL [Naval Research Laboratory] physicist Robert Jastrow used the term Van Allen radiation belt for the first time and the name quickly defined a permanent new landmark in the heavens," wrote historian Abigail Foerstner in her biography of Van Allen.[7]

While Van Allen was enjoying his moment in the scientific spotlight, a few blocks away at the White House, James Killian was laying out for President Eisenhower all the plans and preparations for the Argus experiment that had been worked out over the previous months. The president listened, considered, and gave his approval for the nuclear tests and the rest of the operation. It became official with the issuance of ARPA Order #4: Argus was a go.

Before the day was over, Herbert York informed Van Allen that Argus was going ahead, and that he and his team at the State University of Iowa would be participating. Van Allen was pleased: it was another chance to go into space and do more science.

It did not come as a complete surprise, however. He had already known the broad outlines of Argus for a few weeks, and the probability that satellites would be tasked to detect the Christofilos effect. This practically guaranteed that Van Allen would be asked to participate, since he and his crack team of graduate students had more experience in building space-based radiation detectors than anyone else on the planet at the time.

A couple of months earlier in March, a meeting had been called at the Jet Propulsion Laboratory (JPL), ostensibly to discuss the preliminary results from Explorer 1. Aside from people already quite familiar to Van Allen from Explorer, such as JPL director William Pickering and Army general John Medaris, the meeting was also attended by scientist Wolfgang Panofsky, who had been working discreetly with Christofilos on Argus ideas.

It seemed a bit odd at the time, since Explorer 1 had been in orbit just over a month, and it was early to be talking about any definitive "results" from anything. In effect, however, it was Van Allen's audition for the Argus project.

Van Allen's graduate student George Ludwig recalled in his memoirs: "Although the meeting was openly billed as a gathering to discuss Explorer 1 results, those results were still so tentative that, in retrospect, a meeting of such senior personnel for that purpose was certainly premature. No one in our small Iowa team had made any outside hint of our growing suspicion that the Earth might be surrounded by a previously unknown region of high-intensity trapped radiation. The stated meeting objective was certainly a cover for its true purpose—an early examination of the possibility of orbiting a satellite suitable for detecting and quantifying the Argus Effect."[8]

Van Allen was far from naive. "There were vague allusions at this meeting to the possibility of radiation experiments at high altitudes by the AEC," he remembered.[9] After the JPL meeting, Van Allen kept in touch with Panofsky with phone calls about Explorer 1 results, picking up further hints here and there. As Ludwig noted, "Although none of us at Iowa knew of Argus planning by then, we subsequently became aware of it by degrees."[10]

The following month, when Van Allen informed the officials of the space program and IGY of his Explorer 1 and 3 findings in April, he was formally read into the Argus planning. "At that time, I was introduced to the secret plans for the conduct of the high-altitude bomb tests, later called Argus," he recalled.[11] He found out that it had been his friend William Pickering at JPL who had suggested Van Allen and his Iowa stalwarts for the job.

There was another disturbing revelation. "I also learned that, despite the absence of definitive information, some officials of the Atomic Energy Commission believed that the Soviet Union might have already conducted such tests."[12] If that were true, it was suggested, then it was possible that the radiation belts Van Allen had detected weren't a natural phenomenon—an alarming proposition not only from a military standpoint, but also from the viewpoint of a scientist who had just claimed to make a major discovery.

So Van Allen agreed to come on board, for a variety of reasons. "I was eager to participate in the Argus tests because of their apparent national importance and more particularly because of the possibility of distinguishing between a natural and an artificial population of geomagnetically trapped particles,"[13] he wrote. He, like Christofilos, was sure that what he'd found was not the result of Soviet nuclear meddling. But learning how to distinguish between natural radiation and that caused by nefarious high-altitude atomic activity was obviously a high priority.

Van Allen brought George Ludwig and fellow graduate student Carl McIlwain into the secret. After the formal approval of Argus by the president, matters began to move very quickly. Less than two weeks later, another meeting was held at JPL, and there it was made official: Iowa would build the scientific payload for the upcoming Explorer 4, which would monitor Argus in space. Plans were coordinated between JPL and the Army Ballistic Missile Agency that would launch the satellite, track the craft and collect data. But time was crucial in order to make the launch window for Explorer 4. “The meeting assigned Iowa an unbelievably tight schedule of deadlines,” Foerstner noted. Van Allen’s team had a mere seventy-seven days to get it all done.

For a research scientist like Van Allen, it all might have been something of a conflict. In a very real sense, he was in fact co-opting his scientific work to the military, an arrangement that many scientists would consider a deal with the devil. But Van Allen had already been working under the auspices of the military for most of his career. In World War II, he had worked on proximity fuses and, as a naval officer, helped test them in combat. His postwar sounding rocket and balloon research had been conducted hand-in-hand with the military, using their rockets, ships, and aircraft to carry his instruments to the upper atmosphere and into space. For him, this was a logical extension of all his previous work. Until the establishment of the civilian space agency—NASA—that would come later in 1958, the military controlled access to space.

“While he had fought against military control of scientific space research, [Van Allen] had no qualms about partnering with the military for a defense mission,” wrote Abigail Foerstner.[14] They were the ones with the rockets, after all. And it was certainly not the same as building weapons, as many of Van Allen’s colleagues were doing. True, his findings might have defense applications, but they were also important science.

But secrecy had its own complications. “Explorer 4 was announced as part of a peaceful IGY satellite program, but the design and construction of the instrument package was top secret, and it was used for military purposes,” observed historian James Rodger Fleming. Scientific laboratories and workshops were traditionally bastions of openness and free access for everyone, at least for everyone who was a student or professor or otherwise part of the institution, but Van Allen and his team couldn’t work that way anymore. As they began a frantic quest to build the Explorer 4 instruments in less than three months—“breakneck speed” as Ludwig put it—somebody put up a sign in the lab: “This job is so secret, even I don’t know what I’m doing.”[15]

CHAPTER 4

A Sense of Urgency

AS ARGUS PLANNING ACCELERATED, SECRECY SPAWNED FURTHER COMPLICATIONS. That was nothing new in the world of atomic weapons and the military, but Argus took matters to an entirely new level. Not only did the purpose and concepts of Argus need to remain classified, so did the very existence of the entire enterprise. The reasons were not just military, but also political, diplomatic, and even scientific.

If Christofilos was right and Argus worked—if electrons and charged particles generated by a high-altitude nuclear detonation could be trapped in the Earth's magnetosphere to create an artificial radiation belt—the effect, by definition, would probably be global. The Christofilos theory predicted that particles would spiral around the magnetic lines of force, beginning at the point of generation, whizzing north or southward toward one of the Earth's magnetic poles, then heading back in the other direction toward the opposite pole along the next magnetic force line, jumping from one to the next in an east-west direction. If intense enough, the net effect would be that the field of charged particles would spread longitudinally to eventually circumnavigate the globe and form a "belt."

Obviously, such a phenomenon would not be a localized event like a thunderstorm or even a hurricane. As an official history later explained: "If an ARGUS detonation performed as predicted, it would produce worldwide disturbances in the upper atmosphere that could be monitored by any nation with properly emplaced instrumentation."[1]

No one could do anything about the Soviet Union or anyone else getting lucky and detecting Argus all on their own, of course. That was a risk that had to be taken. But permitting the public or other governments to know about the tests in advance would make it much easier for the Soviets to eavesdrop. Both the US and the USSR routinely monitored each other's nuclear tests and most other military maneuvers from a respectful distance, using aircraft, submarines, ships, and fishing trawlers (spy satellites, though in the works, were still a few years away). That was just an accepted part of doing business in the Cold War, and to be expected when atomic tests were announced in advance. But there was no point in making it easier for the Soviets, especially with something as potentially important as Argus.

Officials became even more troubled when the Soviets launched their third Sputnik on May 15. Unlike its two predecessors, Sputnik 3 featured a suite of scientific instruments to support its IGY mission. That was fine for science, but potentially threatening for Argus. “Since the satellite contained instrumentation for measuring atmospheric radiation, it might be able to detect Argus, if the Soviets knew when and where to look for it,” wrote Lisa Mundey. “American officials worried that the Soviets, should they be given advance warning, might send up specialized satellites to measure the American experiment.”[2] Soviet space activity was yet another reason to keep a tight lid on the project.

Not everyone agreed. At the May 1 meeting at which Eisenhower gave Argus his final stamp of approval, the issue of secrecy versus a public announcement was discussed, briefly but heatedly. “While the DOD [Department of Defense] opposed an announcement,” noted Mundey, John Foster Dulles, then Ike’s secretary of state, “insisted on one.”[3] AEC head Lewis Strauss, though no fan of governmental openness himself, also pointed out that because he would have to inform Congress of the test, as was the case with all nuclear tests, leaks would be inevitable.

Everyone at the meeting was quite aware that this was a wholly unprecedented case. The United States had only ever tested one atomic weapon in total secrecy, and that had been the very first one on July 16, 1945, in the midst of a world war. But now the world was at peace, and attempting to detonate atomic bombs in secret came with the possibility of various unpleasant international repercussions.

There was also the question of the ongoing International Geophysical Year, the IGY, led by the United States and USSR and meant to be a completely open, nonmilitary, purely scientific endeavor, with all data shared freely among nations. That didn’t matter when discussing a non-IGY activity such as setting off nuclear weapons, but launching satellites that were ostensibly scientific, such as Explorer 4, was another matter. How was Explorer 4’s true mission going to be kept secret if the US was obliged to openly publish its scientific data?

It was clear that Argus was simply going to be too big, too wide-ranging, too ambitious an effort to conceal completely. At the State University of Iowa, Van Allen and his graduate students could simply keep their mouths shut and put up a couple of funny signs around the lab, but that wasn’t going to work outside of Iowa City. Cover stories were going to have to be invented for practically everything. To make matters even more confusing, a new secret code word, FLORAL, was officially assigned to the Argus project in order to avoid the nuclear test connotations that the original “Hardtack Argus” designation had acquired. “These plans were to conceal the true intentions of all phases of the ARGUS operation, not only from other nations but also from the majority of DOD personnel participating in the tests themselves.”[4]

Which meant that at that moment, thousands of men serving in the US Navy, US Air Force, and US Army were now destined to participate in one of the most secretive operations of the twentieth century, completely without their knowledge. Aside from the problem of explaining the movement of men, ships, planes, and other military equipment to unknown and unspecified destinations, there would be the problem of organizing, supplying, and carrying it all out.

And where would they all go? Where was Argus to be conducted, particularly given the need and desire to keep its purposes obscured, if not completely secret? Obviously the usual test sites in Nevada and the Pacific were out. It would not be possible to detonate one or more atomic weapons several hundred miles above Las Vegas without the entire US west coast knowing about it. As for the Pacific, it might be easier to keep away curious eyes, but there were other considerations.

On March 1, 1954, the US had exploded a hydrogen bomb dubbed Castle Bravo at Bikini Atoll. It was a test of a new H-bomb configuration, and it exceeded everyone’s expectations, including its own designers. Expected to produce a yield of about five megatons, it was a monster, generating three times that yield. Because of the unexpectedly high yield and tricky winds that shifted the predicted fallout patterns, Castle Bravo ended up dousing a lot of people with radiation, including the civilian crew of the *Lucky Dragon*, a Japanese fishing boat. All of them were affected with radiation sickness; one later died. It was a massive public relations disaster for the US and the AEC worldwide, and became a major impetus for protests that would ultimately lead to the cessation of atmospheric nuclear testing.

Though the radioactive fallout of Castle Bravo had long since faded over the Pacific, the political fallout still persisted for AEC chairman Lewis Strauss. Though he had previously demonstrated little to no concern for the fate of Marshall Islanders or errant Japanese fishermen, he didn't want to risk any further public or press outcry over the testing program. Better, thought Strauss and most others in the AEC and DOD, to find another place to give Christofilos his trial run.

It was bad enough to attempt something as huge as Argus under a shroud of secrecy and deception. But there was also a clock ticking, and it was one that could not be ignored.

Even though President Eisenhower had purposely centered much of his national security policy around nuclear weapons, a concept he called the "New Look," he had been thinking about stopping the testing of atomic weapons for some time, at least since before the 1956 presidential election. From the time he took office in 1953, he had been dedicated to the notion of the "peaceful" atom, the use of nuclear energy for peaceful civilian purposes such as electrical power, scientific research, and medicine, and in general converting atomic swords into civilian plowshares. As a career soldier, he was intimately aware of the military's endless thirst for more weapons and more resources, and the Strategic Air Command, AEC laboratories, and the rest of the nuclear establishment in particular were endlessly rapacious. The Pentagon fought him at every turn, whether by directly opposing his efforts or issuing dire warnings about the mortal danger facing America.

"Eisenhower … had long been concerned about the nuclear arms race and where it was leading us," Herbert York recalled. "Ever since the 'Bravo' nuclear fallout accident in the Pacific in 1954 had raised world consciousness about nuclear tests, [Eisenhower] had mulled over the possibility of a nuclear test ban both as a solution to the fallout problem and as a means for slowing down the arms race."[5] Ike had been forced to back off the issue for political reasons when Adlai Stevenson adopted it as a major part of his platform in his 1956 presidential campaign against Eisenhower. But Ike had been re-elected, and the time was ripe to take action.

Earlier in the spring, Ike directed PSAC to examine the issues concerning a possible nuclear test ban or moratorium. Some scientists in the nuclear arms establishment, such as Edward Teller, were strongly opposed to such a move, arguing that it would gravely imperil America's strategic position. Others, including the members of PSAC, thought otherwise, noting that the US had a firm technological lead in nuclear weapons technology and that the fallout problem needed to be addressed directly.

Eisenhower approached Nikita Khrushchev on April 20 to formally propose an international meeting of experts to talk over a moratorium, and Khrushchev agreed. Soon, serious negotiations were underway for a test moratorium to go into effect before the end of 1958.

That didn't leave much time for an operation on the scale of Argus. The US already had the HARDTACK atomic test series in the works for 1958, divided into two parts: HARDTACK I in the Pacific and HARDTACK II later in the year in Nevada. Given the mind-boggling complexity of organizing and conducting HARDTACK, completing an entirely separate test series from scratch was going to require a herculean effort.

And while HARDTACK was scheduled to include some high-altitude detonations, they would be nothing like Argus: far lower in the atmosphere, far from outer space. That gave added urgency to the necessity of Argus. Another test-ban technical report, this one from a panel of both scientists and military men, observed: "If the high altitude shots at HARDTACK are successful, the U.S will possess weapons effects information important to AICBM [anti-ICBM] and other military developments that will not be available to the same extent to the USSR until a similar test is conducted. But much more effects information will be needed than HARDTACK is likely to provide because the instrumentation for the HARDTACK tests is incomplete, and there are likely to be further important effects that will not have been tested (e.g. ARGUS)."[6]

So Argus was carrying the weight of a great many hopes and expectations. And everything had to be completed before the year was out. The spring of 1958 had been one of secret meetings and conferences, but now that Eisenhower had given the green light, the time for talking was over and the time for action beginning. The first, most basic task was to decide a location for Argus, if not the Pacific or Nevada. Fortunately, Herbert York at ARPA had some good ideas. "I vividly recall poring over maps (something I've always enjoyed) looking for an appropriate site, discovering that Gough Island was in the right place, and then and there personally deciding on that location," he wrote.[7]

Gough Island is a lonely place in the South Atlantic Ocean not far from an even lonelier place, Tristan da Cunha, and an extinct volcano called

Inaccessible Island. They form an archipelago far from shipping lanes, tourist havens, and civilization in general, inhabited by exotic wildlife and a tiny population of several hundred people. From the point of view of Argus planners, the area also had the distinct advantage of being far distant from the Soviet Union or any of its various worldwide interests or allies. In other words, it was perhaps the unlikeliest place on Earth for any stray Russian trawlers, submarines, or aircraft to happen by.

Aside from its geographical obscurity, the area enjoyed another feature that especially recommended it for the Argus experiment. It lay east of a dip in the Earth's magnetic field called the Brazilian or South Atlantic Anomaly, where the magnetosphere was closer to the surface and thus encountered more air molecules. If Argus electrons hit the Brazilian Anomaly, they would be absorbed by air molecules, interfering with and possibly derailing the expected Argus effect. Detonating the atomic devices just east of the Anomaly, however, would give the Argus radiation belt—if it formed—time to expand, grow, and spread eastward around most of the planet before dissipating, allowing ample opportunity to detect and measure it.

Also, it was imperative to observe the "magnetic conjugate point"—the area where the Argus effects were expected to be mirrored along the north-south direction in the magnetosphere. A detonation point in the South Atlantic near Tristan da Cunha and Gough Island placed the Argus conjugate point near the Azores in the North Atlantic, where naval ships could easily assemble and monitor the tests remotely—and without arousing any undue suspicions.

But such a remote operational area as the South Atlantic also posed some serious problems. For one thing, if all went according to plan, it would be August when Argus was conducted, which meant it would be winter in the South Atlantic, with rain, snow, and freezing temperatures—challenging conditions for naval operations under normal circumstances, much less while trying to launch a nuclear missile from the deck of a ship, something that had never been attempted before. Such weather conditions would also complicate routine matters such as the task force ships finding and rendezvousing with one another, refueling and supply, even communications. It was not going to be a pleasure cruise by any means.

An experienced sea hand and administrator would be needed to run the operation. Fortunately, one was available. Captain Lloyd M. Mustin, who was just preparing to assume command of the US Navy's Destroyer Flotilla

Two and accept a concomitant promotion to Rear Admiral, was wrapping up a family vacation in San Francisco and preparing to report to his new station in Newport, Rhode Island, when he received orders on May 19 to report to the Chief of Naval Operations (CNO) in Washington instead.

The CNO informed Mustin that his new duty assignment, though not his promotion, was going to be delayed a bit. The Argus task force, which was going to include not only naval forces but Army and Air Force as well, needed a commander, and Mustin had been chosen. A Naval Academy graduate with considerable combat experience in World War II and a Navy family pedigree that stretched back as far as his great-great-grandfather and the War of 1812, Mustin had had no direct experience with nuclear weapons in his military career, but he had a lot of experience in commanding large, diverse military forces.

Mustin was given office space within the headquarters of the Armed Forces Special Weapons Project (AFSWP) in the Pentagon and began receiving a flurry of technical briefings. The new task force would need a name as well. “We realized that we would need an operational designator of some sort, in order to get all of the communication facilities and the control and the command structure network and so on,” he recalled in an oral history. “We asked for, and got, from the commander in chief, that designator, Task Force 88 [TF 88].”[8]

Meanwhile, the skipper of the USS *Norton Sound*, Captain Arthur R. Gralla, was getting some unusual orders of his own. He discovered that his vessel, which had begun her unglamorous life as a seaplane tender in World War II and later become a guided-missile ship, had been selected as the launching platform for the Argus experiments. It was a natural choice, since the *Sound* had been conducting missile tests, launching sounding rockets, and sending off weather balloons since her conversion a decade earlier.

“It was pretty sure that the *Norton Sound* would be the launch ship,” Mustin recalled in a 1980 interview. “[She] had that big after-deck … in addition, *Norton Sound* had a lot of tracking equipment—telemetry, receiving equipment, so on … she was optimum.”[9]

This particular job, however, was not going to be her usual routine. The ship would require further extensive modifications in order to handle the missile that had been chosen to launch the Argus warheads—the multistage Lockheed X-17a—and to increase its fuel capacity for the extended voyage.

Gralla got his orders, his briefings, and returned from Washington to his ship's home port, Port Hueneme, California, to take his vessel up to the San Francisco Naval Shipyard for refitting. His crew had no idea as yet just what was going on, or where they would be sailing. But that was life for the average sailor.

Mustin put together the rest of his task force. Matters were somewhat complicated by the fact that while the *Norton Sound* was based on the West Coast as part of the Pacific Fleet, the remainder of the assigned ships were in the Atlantic Fleet, based on the East Coast. But if coordination and communications were affected by that reality, such complications also helped to enhance security and to bolster the developing cover stories as to the true purpose of Task Force 88 (TF 88): "TF 88 was identified as consisting of Atlantic Fleet units. This force ostensibly was established by CINCANTFT [Commander in Chief, Atlantic Fleet] to conduct a series of tests of new equipment being introduced into the operating forces. These tests were to be conducted over a wide range of sea and climatic conditions, necessitating a prolonged period of operations at sea."[10] As for the *Norton Sound*, she was said to be "involved in special missile operations requiring preliminary tests on the Pacific Coast Point Mugu Missile Range before conducting a series of firings in a remote area of the Pacific Ocean."[11]

For another TF 88 member, the USS *Albemarle*, the Argus assignment was going to provide a welcome break from some intense duty. The ship had been picked as the floating base of the Navy's newfangled nuclear bomber program, centered on a graceful but ultimately impractical jet aircraft called the Martin P6M SeaMaster. In the era before nuclear submarines and submarine-launched ICBMs, the Navy had been desperately casting about for some entree into the nuclear business, since that was where the lion's share of Pentagon money was to be found. Money had been pouring into the Air Force and its Strategic Air Command bombers for a decade, and the SeaMaster project was the Navy's bid for a piece of the pie. But the project had been plagued with difficulty, including test-flight crashes and fatalities, and would ultimately be cancelled.

"The *Albemarle* was a seaplane tender that … had been taken out of mothballs, and millions of dollars spent in converting her into a tender for that jet seaplane, the P6M, that the Navy spent so much money and time on for so long," recalled Mustin. "It was somebody's supposed secret entry into the strategic nuclear bombing realm, I often thought. But it wasn't very successful … the P6M program was about to be canceled, but it was delayed enough so that *Albemarle* was available."[12]

For the summer of 1958, however, the *Albemarle* would get a break from SeaMaster tests and refittings to serve as the northern monitoring station for Argus in the Azores. She would be positioned at the conjugate point in the North Atlantic, watching for artificial auroras and measuring whatever other Argus phenomena might manifest themselves.

To preserve security, she was not officially designated as part of Task Force 88, but as a vessel that, having just undergone an extensive overhaul at the Philadelphia Naval Shipyard, was in need of a routine shakedown cruise. That would be her cover for the Argus voyage. The Navy also announced that the ship would be working with the Air Force on some long-range communications tests—which was true, after a fashion.

Mustin had other concerns besides security and logistics. One of them was just how many Argus shots would actually be fired. As an experienced sailor and ship handler, he knew very well how rough the seas and the weather could be in the South Atlantic winter, and worried about the prospect of trying to launch a ballistic missile from the deck of a ship—especially one carrying a nuclear warhead. Even disregarding the possible safety issues, it was reasonable to expect that such a feat would take more than one attempt.

It was an issue that, as Mustin discovered, had apparently been given little consideration. "I think initially that's how the thoughts lay, that we would go down there and we would fire one, and that would be that."[13] When he found that several missiles would be available for Argus, he pushed for additional shots. "Somewhere along the line, it became apparent that we could get two of these X-17 rockets modified to carry the warhead. So immediately the plan was to take along two. I hadn't been thinking this thing over very long before the word came from Lockheed that there were enough components around to assemble a third. So I took steps to get that done … when the *Norton Sound* sailed, she was actually carrying three … I know that my thinking, before we ever left, was that if things permit, I would certainly expect to fire all three."[14]

The three-stage Lockheed X-17a rocket chosen for Argus was a thin needle-like research vehicle forty feet tall, developed for the Navy's Polaris missile program as a test bed for heat shields on missile cones. In that capacity, it would be launched straight up, pass through the peak of its ballistic arc, then head straight back down through the atmosphere to subject a missile nose cone to the intense friction heat that would be encountered by a re-entering ICBM warhead.

"It had been used in places like White Sands proving ground and so on, out in the desert, just from crude, simply fixed launchers that you'd aim up in the sky and light her off, and off she'd go," Mustin said. "We, on the other hand, had to launch it from the deck of a ship. It's kind of a cliché to say from the deck of a rolling ship, till you stop and figure what the forecasts are for weather in that part of the world. Almost any time of the year, you name it, that part of the world is pretty uncompromising … down in that part of the Atlantic, there's practically no data, because nobody goes there; the weather is so lousy. The average wind force was gale. We expected the weather would be a factor in anything we did."[15]

But the X-17a had not been designed to carry nuclear warheads. It was simply too small and not powerful enough to loft most of the weapons in the US stockpile, which tended to be large, bulky, and heavy objects.

Still, the weapons labs had been making great progress in warhead miniaturization—one of the payoffs of all the testing in the Pacific and especially in Nevada. It was an effort driven by the ever-expanding plans for more diverse and versatile nukes made not only for the confined spaces of submarines but for use in artillery shells or backpack bombs. The W-25 warheads destined for Argus would be of this generation: low-yield weapons originally intended for air-to-air missiles. They were meant not to obliterate cities, but merely to knock enemy planes and missiles out of the sky.

Which, as Mustin realized, was of little comfort when considering the prospect of such a weapon accidentally detonating in the middle of a naval task force. "This nuclear warhead had nothing but the simplest fuze," he recalled. "It was ignited by the acceleration of the rocket. It was going to run for whatever the time was—700 seconds, or thereabouts, as I recall it—at the end of which time it was going to detonate that nuclear warhead. That's all there was to it. Once it was started, there was no way of turning it off."[16]

In other words, it was not set to go off on impact, but at a fixed time after launch. If a missile were launched off the proper trajectory, or failed to reach sufficient altitude, a disaster could ensue. "The combination of fairly easily predictable malfunctions could find you coming down with a live nuclear warhead, with a fuze that had been armed and was going to go off at some unknown time. This could be anywhere within a radius of quite a few miles from you, at some launching accident or other. So the launching point we picked was more than 1300 miles from land, in all directions."[17]

Quite aside from the possibility of inadvertently nuking someone else, Mustin well knew that "the hazard of this thing coming back down right within our own force was not negligible. And, of course, in later years, to conceive of the AEC ever agreeing to any such thing as this is just so remote that I can't tell you how remote it seems to me. But I suppose the general consensus was that, 'We have no choice; we've got to do it. This is absolutely the best that can be done. An alternate solution of let's don't do it is not permissible. So the heck with it, let's get on with it.'"[18]

As spring melted into summer, that was the attitude that prevailed throughout all the various agencies, organizations, and institutions engaged in Argus. There was a deadline to meet, objectives to be achieved. It may not have been wartime, but it certainly felt like it. For those involved, nothing less than the survival of the free world seemed to be at stake.

CHAPTER 5

The Task Force

THAT SUMMER OF 1958, NEWLY-MINTED REAR ADMIRAL MUSTIN WAS NOT THE only one with rockets on the mind. ARPA, which remained in operational charge of America’s space program until the new and decidedly civilian National Aeronautics and Space Administration (NASA) took over officially in the fall, was making preparations for the Argus satellite missions, Explorers 4 and 5. Two of the Army’s Jupiter C missiles, originally scheduled to launch inflatable spheres into orbit, were retasked for Argus, while James Van Allen and his team busily continued building the equipment payloads back in Iowa City.

Other rockets were also being readied. The Air Force was preparing to launch a bevy of sounding rockets from three different sites on the East Coast in conjunction with each of the Argus shots. The rockets would provide both a backup and a supplement to the data acquired by the satellites, passing through the Argus radiation shell at different altitudes and trajectories.

Although not directly part of the project, the fate of another pair of rockets would be watched closely by Argus personnel: the two Redstone missiles that would launch the high-altitude nuclear shots of HARDTACK, dubbed Teak and Orange. Everyone knew that while these tests wouldn’t negate the necessity or the motivation for Argus, they still held the promise of some intriguing results that would be directly related to and perhaps even markedly enhance the impact of Argus in scientific and military circles.

Unlike the comparatively humble X-17as that would carry Argus into space, the Redstone was a serious missile, almost seventy feet long with a thrust of over 61,000 pounds. In its modified Jupiter C configuration, it had carried America’s first satellite, Explorer 1, into orbit, but was capable of lofting far larger payloads, such as the hydrogen warheads of Teak and Orange, which were weapons that weighed about three tons and gave a nuclear yield of 3.8 megatons.

As with all the other Pacific nuclear tests, secrecy was not a major issue for these shots. Johnston Island, already well-established as part of the US Pacific Proving Grounds, underwent massive preparations before the shots, including the construction of a launching pad, liquid-oxygen fuel plant, concrete observation bunkers, and extensive instrumentation arrays for monitoring, photographing, and recording the proceedings. A variety of aircraft were assembled for observation, recording, and search-and-rescue operations, along with a flotilla of ships. Unlike the wilds of the South Atlantic, Johnston Island was one place where the US military and scientific establishment could set up everything precisely as they wanted it.

Originally, the Teak and Orange shots had been scheduled for launch from Bikini, but AEC Chairman Lewis Strauss, in an uncharacteristic display of concern for the native Marshall Islanders, whose entire way of life had been disrupted by the test program ever since it began in 1946, worried that the high-altitude bursts, which would be visible over a far greater range than usual, might injure or permanently blind indigenous personnel, not to mention anyone else who happened to be in the area. The memory of the Castle Bravo debacle and the resultant bad publicity was still fresh in his mind.

Upon further study, the Department of Defense and the government labs concurred. “Results of theoretical calculations on the optical thermal yield of these weapons when detonated in the upper atmosphere became available indicating that such detonations would be bright enough to cause permanent retinal injury to observers of the bursts,” noted a Defense Department history of HARDTACK. “These calculations had only recently been completed by the DOD. Because some 11,000 Micronesians would have been close enough to view the very high altitude bursts at the EPG [Eniwetok Proving Ground], thus risking retinal damage, the Secretary of Defense and the Chairman of the AEC decided on 7 April to change the location of the test to Johnston Island.”[1] There were not going to be any further *Lucky Dragon*–type public-relations fiascos this time. Johnston Island was suitably remote, more than five hundred miles away from the nearest inhabited areas, even if moving the operation there entailed greater logistical difficulties.

But the shots would have other repercussions, which would not come as a surprise to Nicholas Christofilos and would also provide further impetus for Argus. Teak was launched shortly before midnight on July 31, 1958. Set to detonate over water some distance away from the island, a guidance system glitch instead caused it to explode directly over Johnston Island at the planned altitude of about fifty miles, causing something of a shock to observers on the ground. By all accounts, Teak was a spectacular sight, creating an enormous, brilliant, multicolored fireball in the sky that not only dazzled the official observers in the immediate area but was also visible as far as seven hundred miles away in Honolulu.

Hawaii got more than just a dazzling light show. The blast poured electrons into the ionosphere, blacking out radio and radar over a broad range of the Pacific as far as Australia. “The red glow remained clearly visible in the southwestern sky for half an hour,” recounted a Defense Nuclear Agency history.[2] It was an apocalyptic sight: “One air force officer watching the display fantasized that this was what a nuclear war might look like,” noted James Fleming.[3]

The people on the scene at Johnston Island seemed to have suddenly dropped off the face of the planet—or perhaps, had been blown off of it. “In Honolulu, military and civilian air traffic communications were interrupted for several hours. At the AFWSP’s offices in the Pentagon, [AFSWP commander] Admiral Parker grew concerned for the personnel on Johnston Island as hour after hour passed with no word regarding the test. Finally, some eight hours after Teak had occurred, the word that all was well came from [A. R] Luedecke, the commander of Joint Task Force 7 … The communications blackout worried others as well. Later AFSWP learned that one of the first radio messages received at Johnston Island once communications had been restored was: ‘Are you still there?’”[4]

The Orange shot about two weeks later, though nearly identical in design, was something of an anticlimax, occurring at a lower altitude and proving to be considerably less picturesque. It also failed to produce the widespread electronic havoc of Teak, though some effects were still reported.[5]

The final verdict was somewhat equivocal. Though Teak and Orange, along with a low-yield balloon shot at low altitude called Yucca, weren’t enough to conclusively confirm or deny Christofilos’s ideas one way or another, they did demonstrate that something unusual happened up there when atomic weapons detonated in the twilight zone where the Earth’s atmosphere transitioned into the void of outer space. But not everyone was satisfied. “While some valuable information had been gathered from Teak and Orange, many scientists in the nuclear weapons community considered the tests to be only partially successful,” noted the DNA history. “Neither detonation had occurred where it had been planned and, due to cloud cover, detailed photographic coverage was incomplete.”[6] There were some calls to repeat the Teak test, but these were dismissed in the face of the impending nuclear test moratorium.

All of which served to place further emphasis on Argus. As preparations accelerated relentlessly, anticipation grew. After all, Teak and Orange had not been specifically designed and targeted to create the Christofilos effect. What would happen with Argus, intended to do just that?

IT HAD BEEN A BUSY SUMMER FOR ALL CONCERNED, FROM THE HALLS OF THE PENTAGON and the offices of Admiral Mustin, to the basement lab of James Van Allen in Iowa; from the shipyards of San Francisco, Philadelphia, and Norfolk, to the decks and compartments of the *Norton Sound*. After completing refits in San Francisco, Captain Gralla had taken the *Sound* back into the Pacific off the southern coast of California, to the Naval Air Missile Test Center Sea Test Range. Under the tutelage of technicians from Lockheed Missiles Systems Division, the crew practiced assembling and preparing the X-17a missiles for firing in a ten-day training course in Van Nuys, California. While the *Sound*’s crew were experienced missileers, this particular vehicle was a new animal for them, and there could be no margin for error.

Back in Iowa, the Van Allen team was laboring to prepare the Explorer 4 and 5 instrument packages for launch. Fortunately, the importance of the project helped to grease the wheels: “The Argus Project was helped immeasurably by the assignment of a very high military priority that helped to cut through the red tape and delivery delays,” remembered George Ludwig.[7] That was a good thing, because apart from the technical challenges, constant coordination was necessary among all the project principals. Ludwig, Van Allen, and the rest of the team had both civilian and military aircraft readily available to fly themselves and equipment between Iowa City, Washington, and Huntsville, Alabama, where the Jupiter rocket that would loft Explorer into orbit was being put together. Tests had to be made to ensure that the instrument package would work flawlessly with spacecraft systems, communications setups, and even that it would fit inside the confines of the rocket shell. Again, there was no margin for error. The satellite data was going to be all-important, because ground observations and sounding rocket flights were not going to provide enough hard data to confirm and characterize Christofilos’s predictions. That would require sustained measurements of the predicted radiation shell that could only be provided by a satellite. And with a project deadline of September 1, 1958, now firmly imposed by the powers that be, there would be no opportunities to repeat the Argus experiment. “We had to get it done by the first of September, or our name was mud,” Mustin recalled.[8]

Ludwig himself took two trips to Huntsville in June, carrying first the Explorer instrument package prototypes and then the actual flight units for various tests and preparations. The classified nature of the entire business was something of a mixed bag. “Despite the secrecy, we could build all of the equipment in the open, since the satellite and its instrumentation served officially as an International Geophysical Year (IGY) program to extend our investigation of the natural radiation discovered by Explorers I and III,” Ludwig wrote. “Only the second mission to study the nuclear blasts was held in strict confidence by a small group of us who were building the instrument. In fact, only Van Allen and [Carl] McIlwain had access to the full range of details. My knowledge was limited to a basic understanding of the mission and to details necessary to build the instrumented satellite, test it, and interface it with the launch vehicle.”[9]

He wasn’t the only one working in the dark. Out on the West Coast, the *Norton Sound* spent the month of July test-firing X-17a missiles from her fantail launching area. The test version—a configuration of the X-17a known as the Winder missile fitted with a special warhead loaded with telemetry equipment—turned out to be a tricky beast. While the first test-firing at sea went well, hurtling to an altitude of 302 miles, matters quickly became more problematic.

Navy missileman Dick Culp worked as part of the telemetry station team aboard the “Snortin’ Norton.” “The missile itself was originally designed as what was called a nail-driver,” he remembered. “The first stage would take it out of the atmosphere, then it would topple and the second two stages would fire and drive it down into the atmosphere.” The purpose was to test the reentry characteristics of different nose cone shapes and materials. But for Argus, Culp said, “we just sent them all straight up.”

As with many other rocket designs, the X-17a first stage employed a spin package—small retrorockets that would fire upon launch to send the missile spinning on its long axis, imparting greater flight stability. The spin motors would be automatically jettisoned once the missile was in flight and on course. “The idea was once it came off the launch pad, they would fire and they would get the ballistic motion going,” Culp noted. “In the early years, the retros were slightly overpowered and they unscrewed the rest of the rocket and it all collapsed.”

On the second test-missile firing, said Culp, “they used a captive fin configuration which worked well.” But not well enough, apparently. About twenty-five seconds after launch, “it basically took itself apart,” apparently because of resonant vibrations that were too much for the missile’s structural integrity. The third test suffered a similar fate.[10]

Something obviously had to be changed. A missile coming apart over the ocean loaded with nothing but telemetry equipment was a reasonably innocuous picture, but the same scenario involving a live nuclear warhead was not acceptable. After a tense conference, the missile team decided to dump the spin rocket package and make some adjustments to the stabilizing fins. That seemed to do the trick, and a fourth test on July 24 was successful, soaring to 362 miles.

Still, that made only a total of two successes in four attempts. A 50 percent success rate might be good enough for many endeavors, but nuclear weapons demanded a far greater batting average. Unfortunately, it would have to do, because time was rapidly running out. Only three more X-17a missiles remained available, and they would all be needed for Argus. And with a long voyage ahead of her, the *Norton Sound* needed to get underway.

The *Sound* left the Navy’s Pacific missile test range and returned home to Port Hueneme to get ready. Lockheed missile technicians worked twenty-four-hour shifts to finish the assembly and preparations of the remaining missiles and to get them loaded aboard ship. Sometime in those remaining few days, technicians from Sandia National Laboratory quietly loaded three 1.7 kiloton W-25 nuclear warheads aboard the *Norton Sound*, their presence known only to Captain Gralla and a select few.

Among the discreet visitors to the *Norton Sound* before her departure was a bespectacled civilian with a taciturn, serious manner: Dr. Frank Shelton, the technical director of AFSWP. “One of the things I wanted to discuss with Captain Gralla was the role and help the Sandia Corporation people would provide on board the *Norton Sound*,” he recalled. “They would take care of arming, fusing, safing and firing of the nuclear weapons. Having been employed at Sandia, I was very familiar with these people.” After witnessing one of the test launches on a brief trip aboard the *Sound*, Shelton returned to the Pentagon and met with Nicholas Christofilos to discuss the Explorer 4 and 5 Argus satellite measurements. Meanwhile, the ship's company was joined by Commander Bob Wertheim, who would serve as Argus missile officer.[11]

Most of the rest of the crew had no idea of what they were about to undertake. "We knew we were going on a cruise that would be about sixty days," recalled Navy electronics technician Keith Mayfield. "No information as to where or what for."[12] Dick Culp concurred: "We knew we were going to be doing something fairly major, and nobody had any idea where it was." Everyone knew that the mission would have something to do with firing missiles—that was the ship's job, after all. And obviously, it was reasonable to assume that they would be working with the same Lockheed X-17a system they'd been training and practicing on for the last couple of months. But firing the missiles from where, and carrying what, exactly? As usual in the military, such details were only for those deemed to have a "need to know," and the crew, at least for now, didn't need to know much.

Neither did many other people. "Secrecy was the watchword," Admiral Mustin confirmed. "It was thought that if the Russians found out what we were doing, they might choose several courses of action, any one of which we wouldn't like much." For one thing, given the international feeling at the time regarding atomic testing and a possible test ban, Mustin thought that one thing the Russians could do "would be to raise a big hue and cry and appeal to the ban-the-bomb freaks and so on, and get the test called off." Or on a less political, more practical level, "if things worked out more or less as expected, they [the Russians] could put up some instrumentation, too. They could learn a lot of technical results from our test and perhaps get as much information out of it as we did."[13]

Security and secrecy involved not merely silence, but outright deception. "There was a lot of both cold weather and tropical weather gear brought aboard, so there was a lot of speculation as to where we were going," Keith Mayfield said.[14] The word went out that the Navy was going to be conducting unspecified test operations in the Arctic. Crew members were even shown films about the Arctic and cold weather operations. Such subterfuge extended all the way up the chain of command and beyond as *Norton Sound* departed Port Hueneme at 6 PM on August 1st, sailing for parts unknown to most.

“We had an elaborate cover scheme,” Mustin recalled. “She sailed from Point Mugu, Port Hueneme. She sailed west, and she was bound for test operations in the Pacific, ostensibly.” Unlike most vessels traveling from the Pacific to the Atlantic, the *Sound* would avoid the Panama Canal. As AFSWP technical director Frank Shelton explained, “We did not send the ship through the Panama Canal for security reasons. The Russians noted all naval vessels transiting the Canal.”[15]

Mustin continued, “All of the ship’s radio traffic was broadcast on the Pacific Fleet schedule. And we had made arrangements that all this traffic was then recorded by a naval communications station somewhere, I’ve forgotten where, encrypted in full, including the call signs—we didn’t have encrypted call signs in those days—and rebroadcast on the Atlantic schedule. So she, to anyone trying to find out anything about her by radio traffic analysis, was still in the Pacific, obviously, because traffic addressed to her was being transmitted to the Pacific. But it was reaching her completely covered.”[16] Another tactic was the use of plain-language cover messages containing coded meanings.

With the ship safely underway and any contact with the outside world now strictly controlled, the crew learned a few more tantalizing details. “The crew was informed that we would be going to the South Atlantic,” said missile telemetry crewman Ken McMaster.[17] Recalled Dick Culp, “It was after we left. That’s when they told us we’d be going around Cape Horn and firing in the South Atlantic. That’s basically all they told us.”[18] Until the end of Argus—a term that even the *Sound*’s crew had not yet heard—the *Norton Sound* would be a ghost ship, alone, silent, cruising toward a mysterious rendezvous in the middle of nowhere on a most secret mission.

Which, of course, only encouraged speculation both above and below decks. “During the cruise I learned, through scuttlebutt, that we had atomic warheads aboard,” Ken McMaster remembered. Were they for testing purposes, scientific research, or was the *Sound* on her way to begin World War III? No one knew for sure, but such questions made for spirited discussions around the wardroom and in the berthing spaces.

The crew of the *Sound* had other distractions, however. Captain Gralla kept the missile-handling teams busy with repeated drills and simulated launches, not just in good weather and daylight but at night in the poorest conditions they could find. They practiced wrestling the X-17a onto its portable launch trailer on the *Norton Sound*'s fantail deck, trying to determine the worst conditions under which a launch might still be conducted. After much trial and error, the missileers found that launching was possible in winds of up to forty knots and sea swells up to sixteen feet, which were fairly alarming, if not uncommon, conditions. Finally, the crew demonstrated that they could get a missile out of storage, rolled out on the deck, secured in place, and erected in firing position in just about forty-five minutes. No one realized quite yet just how valuable all this exhaustive practice was going to prove.

In the days after *Norton Sound* set sail for the South Atlantic, the eight other vessels of Task Force 88 left their ports on the East Coast, including the *Albemarle*, the oiler *Neosho*, the destroyer *Warrington*, and the venerable aircraft carrier USS *Tarawa*, which would serve as Admiral Mustin's flagship for the task force. Most of the ships sailed south, while the *Albemarle* headed for station at the Azores. Operating under the same strict security blackout as the *Norton Sound*, the crews aboard these vessels kept occupied with their own drills and exercises, which included launching small Loki/Dart antiaircraft missiles at sea to practice radar tracking and other Argus support functions.

Far above the Atlantic and Pacific, in an orbit ranging from 164 to 1381 miles, Explorer 4 was ready. It had been launched on schedule at 10 AM on July 26 from the Cape Canaveral Air Force Missile Test Center, just in time for the Teak test that closed out the month. The Teak and subsequent Orange shots provided a bit of a shakedown for Explorer 4, but were still at far too low an altitude to do much more than gently tickle Van Allen's onboard instruments. Most of the charged particles emitted by the blasts were soaked up in the dense lower atmosphere, as expected. But the satellite and its instrument package had proved to be healthy, functioning, and ready for Argus.

Unfortunately, Explorer 4 would be conducting its spaceborne observations of Argus all alone. After several delays, its intended companion, Explorer 5, launched from Cape Canaveral on the morning of August 24. But the final stage of the Jupiter C missile failed to fire, and Explorer 5, along with Van Allen's painstakingly designed and crafted instrument package, fell back to sea to a final destination at the bottom of the Atlantic.

No matter. All was in motion: plans made, ships sailing, everything coming together. The first phase of Operation HARDTACK was wrapping up in the Pacific, to be followed by its Nevada phase in the fall, and then, assuming that international agreements and political goodwill prevailed, the nuclear test moratorium would take effect, for however long that goodwill persisted. Back at Lawrence Livermore Laboratory in California, Nicholas Christofilos knew that the Argus tests would be among America's last nuclear tests for quite a while—perhaps even forever, if some people got their way. If his theories were going to be proven correct, if he was going to be vindicated, this was the time, the only opportunity he might ever have.

It was now or never.

CHAPTER 6

The Farthest Place on Earth

FOR MOST PEOPLE, THE SOUTH ATLANTIC OCEAN IS LESS A DESTINATION than just a place to pass through on the way to somewhere else. Very few tourists or other casual visitors venture there, probably due to the lack of amenities and easy communications with the outside world. Admiral Mustin described it as "almost a maritime desert. It's just been a place that people stayed away from."[1] All of which made it a perfect stage for Operation Argus

Mustin, now aboard his flagship *Tarawa* and leading Task Force 88 southward, busied himself with various preparations. His meteorology officer had discovered weather maps of the South Atlantic drawn years before by South African observers, and poring over them gave Mustin a good idea of the fickle and infinitely changeable weather patterns in the area. Mustin brought together the captains of the other TF 88 vessels for highly secret briefings, ferrying them over to the *Tarawa* by helicopter. "I had told them what we were going to do, and why we were going to do it; and what the security implications were, and what the hazard implications were; and that they could tell no living soul except their exec [executive officer], and he could tell nobody," said Mustin.[2]

Launching the Loki sounding rockets from the deck of the destroyer USS *Warrington* gave the task force practice at radar tracking and detection. "This gave us a pretty good rehearsal," Mustin recalled. "It also added a lot of visible activity, of a perfectly innocent nature, for all the ships' crews and so on to see. The story was that we were doing some high-altitude experiments."[3]

The *Tarawa* and her aircrews also had the opportunity to practice what would be one of her main duties during the Argus operation: maintaining security. "We knew that we would need a considerable degree of surveillance around the area, for safety's sake and others," Mustin said. Airplanes and helicopters from the *Tarawa* would patrol a perimeter around the task force, keeping an eye out for Russian trawlers, submarines, and other suspicious observers. None were definitively sighted, but Mustin was ready for them, with plans in place to turn away from any unwanted company and if necessary even split up the task force, spread out his ships over a wide area, and rendezvous again later at some predetermined point.

An ocean away on the other side of the planet, *Norton Sound* continued ahead on her own solitary odyssey. The missile handling and launching drills were briefly interrupted by the traditional "shellback" initiation festivities for the "pollywog" crewmen who were crossing the equator for the first time. It provided a mostly welcome diversion from below-decks scuttlebutt, daily routine, and the mysterious mission on which the vessel was embarked, the details of which were still unknown to most of the crew. The official "Crossing the Line" certificates awarded to the new shellbacks had been among the various supplies loaded aboard the *Sound* and the other task force vessels before departure—in cartons all labeled Top Secret and delivered personally to ship captains in order to preserve security.[4]

Another highlight for the *Sound* crewmen came a few days later on August 17, as the ship went "round the Horn" of South America and entered the Atlantic. Becoming a shellback and going around the Horn on the same voyage granted them the exalted status of "horned shellbacks"—something of which few US sailors could boast.

It was obvious by now that whatever the *Norton Sound*'s ultimate destination, it was not going to be a tropical paradise, nor would it be the Arctic. But the transition from summer in the Northern hemisphere to winter in the Southern hemisphere was striking and obvious, marked not merely by the occasional iceberg passing by but also with the icy winds and choppy seas that lashed the ship. With a length of 540 feet and beam of almost seventy feet, the *Sound* was a fairly large vessel. The design of her hull made her stable to roll, but, as Mustin noted, "surprisingly prone to pitch." As sea and weather conditions grew steadily more challenging, the value of all the practice drills insisted upon by Captain Gralla at the onset of the cruise became clear.

After steaming south for most of her voyage thus far, the *Norton Sound* now headed north, bound for the farthest place on Earth. The first vessel to arrive on her assigned station was much farther north, the *Albemarle,* which took up her post in the Azores on August 23. Meanwhile, the rest of Task Force 88 arrived in the Argus operational area, the lee of Gough Island in the

Tristan da Cunha archipelago, miles from the nearest land. “The weather was lousy,” said Mustin. “Gigantic swells were rolling past.” But then, they had been expecting as much.

Fortunately, they wouldn’t have long to wait for the star performer of the upcoming show. Late that afternoon, lookouts on the *Norton Sound* reported to Captain Gralla that they had sighted the *Tarawa*. The *Sound*’s radioman dispatched a droll message to Task Force 88: “Doctor Livingstone, I presume?”

One of the most unusual military operations in the history of the world had officially begun. In the next several days, the men aboard this small flotilla in the middle of nowhere would attempt to do something that had never been done before.

AS THE MILITARY CONTINGENT OF ARGUS CONTINUED TO GEAR UP, SO DID THE scientific corps. Data tapes from Explorer 4 poured into the Iowa City lab bearing data from Teak and Orange, all of which needed to be reduced and analyzed before the impending Argus shots added to the already impossible workload of Ludwig, McIlwain, and the other Van Allen acolytes. The failure of the Explorer 5 launch added to the pressure, since it left Explorer 4 the sole orbital observation post for Argus.

But there would still be some backup for Explorer. While the Explorers, blessed with the official imprimatur of the International Geophysical Year, were at this point the only public operation connected with Argus (though not, of course, to the public’s knowledge), other preparations were also coming together in August 1958. One was an audacious, frantically conducted effort by the Navy, originally conceived in the rush of post-Sputnik panic less than a year earlier.

Officially, the Navy already had a dog in the fight for American satellite dominance with the Vanguard program, notorious for its embarrassing launch failure on December 6, 1957. While the Army Ballistic Missile Agency (ABMA) famously saved America’s pride at the end of the following month with Explorer 1, Vanguard also redeemed itself not long afterward by finally launching the second US satellite on March 17. The Vanguard project was destined to be taken over by civilian hands upon the birth of NASA on October 1, 1958.

Unofficially, however, while Vanguard and ABMA vied to even the satellite score with the Soviets as well as each other, the people at the Naval

Ordnance Test Station (NOTS) in China Lake, California, where the Navy developed and tested weapons under top secrecy, had their own ideas. At first they focused on the conventional concept of launching satellites from the ground, but the ABMA had a lock on the requisite rocket technology. Then, an inspiration: what if a smaller rocket was launched from a jet fighter at high altitude to kick a satellite into space?

Much like Argus, it was another of those "so crazy it just might work" notions that flourished in the frenzied atmosphere of the Cold War, and the NOTS scientists and engineers set to work devising Project Pilot, later unofficially but universally dubbed NOTSNIK (NOTS for Naval Ordnance Test Station, with the -NIK suffix as a nod to Sputnik). The NOTS team proposed using a specially-modified Douglas Skyray F4D-1 jet to launch a small multistage rocket carrying an even smaller satellite. The reporters who had derided Vanguard's first unsuccessful satellite as an aluminum grapefruit would have been even more amused by the NOTSNIK satellite package, an eight-inch-diameter plastic donut stuffed with rudimentary electronics weighing just over two pounds.

Still, the NOTS team managed to wrangle some research money out of Navy officials in Washington, and set to work under complete secrecy, hoping to startle the world. In a canny move, they soon got more money by proposing that NOTSNIK could serve as a backup for Explorer 4's Argus observations. That hope became the driving force for the project—under, as with most everything else associated with Argus, impossible deadlines.

Unfortunately, despite its best intentions and clever conception, NOTSNIK would turn out much as Vanguard's first effort, though thankfully wholly out of the public eye. Several launch attempts in late July and in August before the Argus shots were all unsuccessful, and the Navy pulled the plug. Still, some of the NOTSNIK ground stations did manage to collect some useful Argus data from Explorer 4 to supplement other observations. (It would not be the end of the concept of aircraft-launched space vehicles. The Air Force would revisit the idea in the 1980s as a possible means not of launching satellites, but of shooting them down.)

The quiet failure of NOTSNIK didn't leave Explorer 4 entirely on its own, however, nor would the Navy get all of the Argus action. While the Navy was busy assembling task forces and attempting to launch rockets from fighter planes, the Air Force Special Weapons Center was preparing Project Jason, in which a series of high-altitude sounding rockets would be simultaneously launched from various sites along the East Coast to pierce the expected Argus radiation belt and make scientific measurements.

Though scheduled to coincide with the Argus launches, one Jason experiment was conducted early, both as a sort of dress rehearsal and also to provide a calibration measurement for the later shots. On August 15, several days after the Orange high-altitude nuclear test over Johnston Island in the Pacific, a Jason rocket was launched from Patrick Air Force Base at Cape Canaveral. As with the Jason shots that would follow, it was a five-stage solid-fuel rocket loaded with instrumentation, including radiation sensors and telemetry equipment. The three sites set for the big show were Patrick; the National Advisory Committee for Aeronautics (NACA) station at Wallops Island, Virginia; and Ramey Air Force Base in Puerto Rico, with each station respectively dubbed Papa, Whiskey, and Romeo. Shortly after the Argus rockets left the deck of the *Norton Sound*, each site would send forth its rockets. Since they would penetrate the presumed Argus radiation shell from the ground up in a more or less perpendicular direction, and only for a brief period, the Jason sounding rockets weren't expected to provide as comprehensive a data picture as that expected from Explorer 4. Still, they would serve as an important complement to and perhaps confirmation of whatever Explorer had to report.

Argus would also be heavily monitored from below, an effort officially designated as Project Midas. This would include the observations from Task Force 88 vessels, including the *Albemarle* at the North Atlantic conjugate point, as well as ground stations and aircraft from airbases in Portugal and Spain. Further monitoring would be conducted at other locations around the globe.

Whether visual phenomena, geomagnetic disturbances, radio interference, or something else completely unexpected, the effects of Argus were not about to go unobserved. Everyone involved realized that here was a unique opportunity that might never come again.

BACK IN THE FRIGID, TURBULENT SOUTH ATLANTIC ABOARD THE *TARAWA*, Admiral Mustin was worried about the weather.

It was not looking good. His meteorologist, Commander Max C. Jack, had continued to study whatever historical data he could find about weather patterns in the area. Most of the major storms in the South Atlantic, he discovered, appeared to originate around two major points: one just off the tip of South America, and the other near Buenos Aires. After formation, a storm would usually follow a very predictable path eastward across the Atlantic. Whichever origin point, the paths happened to converge in a most unfortunate location: “the spot that was our chosen launch point,” Mustin remembered.[5]

But that was only in theory. Reality was bad enough. “It snowed and all sorts of things,” Mustin said. “It really was truly winter. It would be bright sun one minute, and just horizontally driving snow the next. Wind from the east, wind from the west, whoever knew what. These circular storms would go by.”[6] Even routine operations, such as refueling the task force vessels from the oiler *Neosho*, became hazardous tests of endurance in the rough, cold seas.

The only up-to-date weather observations available came from low-power radio stations broadcasting from South Africa, Rio de Janeiro, Buenos Aires, or the Falkland Islands, and reception was spotty at best. Since the presence and purpose of Task Force 88 remained top secret, direct inquiries to outside civilian weather stations were out of the question. Further complicating matters was the fact that it was generally impossible to apply whatever limited data could be obtained from South American stations and those in South Africa to make any kind of coherent forecast. Mustin decided to deploy the two destroyer escorts in Task Force 88 to serve as a weather picket. “The reason was that the prevailing winds were from the west, and the storms approached from the west,” he said. “These little ships were better in that kind of heavy weather than the World War II destroyers” (also serving in Task Force 88). The two destroyer escorts took turns on weather station, deploying about three hundred miles west of the main task force, which gave the main force about seven hours advance warning of bad weather.[7]

It was going to be a day-to-day, hour-to-hour situation. The value of the repeated missile drills, both those in good weather off Point Mugu on the other side of the world and those conducted in forty-knot winds and sixteen-foot swells was becoming painfully obvious. The Argus shots were not going to go off in ideal conditions.

As the man in charge of the entire ball game, Mustin had more to think about than simply launching atomic missiles off of a ship. The weather would also play a key factor in the observations that could be made and the data that would be collected. The worldwide network of other observers on sea, earth, air, and in space would be unaffected by the weather in the South Atlantic, but that was still where the action was going to happen, the ringside seat. The other ships of Task Force 88 would be conducting their own observations, as would specially instrumented aircraft from the *Tarawa*. Heavy cloud cover, much less snow and wind, would spoil the show for everyone, not to mention increasing the hazards. Mustin noted that he didn't much like the idea of his aircraft "up there in the dark, above the clouds, then coming down through a 20,000-foot cloud layer, to land in the black of night on a deck with blowing snow on it."[8]

For Argus to work, the X-17a missile had to be launched from the *Norton Sound* at a nearly vertical trajectory, which meant being able to predict and compensate for the winds as precisely as possible. The missile launcher was not designed for continuous adjustments, "like, for example, a modern naval gun that stays aimed at a fixed point in space while the ship moves around underneath it," Mustin explained.[9] Because of the great acceleration of the missile, the wind would have little if any effect after launch, but launching at a proper trajectory was critical.

One small consolation, both for Admiral Mustin and the task force crew in general, was that fallout was not going to be an issue. Almost all other atomic tests in the Pacific and in Nevada had to pay close attention to the weather not just to ensure optimal conditions at test time but also to predict and prepare for possible fallout wind patterns after the shot. With the Argus detonations occurring at an altitude of several hundred miles above the earth, there was no reasonable possibility of fallout. Whatever else happened, there would be no Castle Bravo/*Lucky Dragon* fiasco with Argus.

The issue of radiological safety had been a somewhat delicate subject for Argus planners, however. The typical procedure, as practiced for nuclear tests in the Pacific, was to issue film badges to all personnel who might conceivably be exposed to radiation. But in those cases, everyone knew going in that they were about to participate in a nuclear test.

Not so with Argus, being conducted in utmost secrecy at the bottom of the world. "The security aspects of the Argus experiments precluded the operation of the type of radiological safety program that is common to nuclear testing," said the final task force report, adding ominously, "It was therefore decided that the interests of the government should be protected against possible future lawsuits by a radiological safety program that would not reveal to personnel of the task force that nuclear testing was involved in their operations."[10]

Although as per standard practice, the Navy had obtained four thousand film badges, enough to supply every member of the task force if necessary, they were actually given only to select people, those already aware of the true nature of Argus. *Norton Sound* crewman Dick Culp wasn't one of them. After developing bladder cancer later in life, he eventually received $75,000 through a compensation program established by the Department of Justice in 1990 for veterans who contracted certain types of cancer linked to atmospheric atomic testing. "I think there were a fair number of people who actually got compensation for that," he recalled. "And even some that were not out on the high decks. In the engine room there were a couple of them that I know were compensated." But without any kind of radiological exposure records, a direct causal link is impossible to establish. "Basically, if you could prove you were on the ship and you had medical records that proved you had one of the selected cancers, you got your payment," said Culp. "I don't know that anything can be taken from [that], other than it happened."[11]

Said Mustin, "We couldn't accept issuing every man in the task force a film badge … because this would establish beyond a shadow of a doubt the nuclear association of what we were going to do. We simply couldn't afford to have that revealed until quite a bit after the fact."[12]

So only select personnel, including the pilots of the aircraft who would conduct airborne observations and the personnel aboard the *Norton Sound* directly involved in handling the nuclear warheads, received radiation film badges. Additional film packets were surreptitiously placed in exposed open-air locations on all the task force ships to monitor post-shot radiation, if any. Meanwhile, during the shots, the *Norton Sound* would be buttoned up as tightly as possible under the same precautions prescribed for an atomic attack—just in case.

Such precautions, of course, did not preclude the possibility of a launch mishap bringing a 1.7-kiloton nuclear warhead down in the middle of the sea to obliterate Task Force 88.

The troublesome weather also helped to somewhat mitigate another concern, namely operational security. The *Tarawa* had already been conducting routine air patrols twice a day with her squadron of Grumman

S2F Tracker fixed-wing aircraft, ensuring that no unwanted company came near the task force, whether accidentally or intentionally. While the patrols continued in the lead up to the test shots, the bad weather did help to ease fears about uninvited guests in the form of Russian submarines or fishing trawlers.

With Explorer 4 also up and humming along in orbit, yet another complication arrived for Mustin to deal with. “We were supposed to launch [the missile] so as to get the detonation at a time when the satellite was in a certain spot on its path around the earth.”

It all amounted to an intricate operational dance of ships and aircraft, which also had to be coordinated with the *Albemarle* up north at the magnetic conjugate point, the Jason sounding rockets, Midas observation planes, ground observers, and all the other monitoring stations around the world.

But there was time for one more dress rehearsal. On August 25 and 26, the *Norton Sound* fired off four small Deacon sounding rockets to simulate the main event, giving everyone a chance to practice their jobs and coordinate techniques. One of the most challenging jobs fell to the Grumman S2F Tracker aircraft. “We wanted—if we could get it—to have some kind of visual observation above the clouds. So quite a while before launch time, we would launch four S2Fs to struggle up to get on top of the clouds, which really was just about at, if not slightly above, their intended operating ceiling,” explained Mustin. The S2F was, after all, designed as an antisubmarine aircraft, intended to operate at relatively low altitudes above the water to search for enemy subs, not to pierce the heavens like a jet fighter. Unlike fighter aircraft, they also didn’t carry oxygen for the crews to accommodate high-altitude operations. The crews had portable oxygen equipment, but that limited their range.

“We would station them such that, at a certain point in the countdown, the four planes would be at the four corners of a square, centered above the launching ship. Each one would start in the same direction around the perimeter of this square so that, hopefully, when the rocket went by, they’d be in a position … [to] get a pretty good look at it.”[13]

Aboard the *Norton Sound*, Lockheed personnel along with select Navy missilemen and Sandia technicians prepared the first X-17a for launch. With the missiles on their portable wheeled gantry, “getting them out there [on deck] in the weather was rather interesting,” missileman Dick Culp wryly recalled.[14] Again, this was where the repeated practice drills—not to mention the heavy cold-weather gear that had been loaded aboard back in Hueneme—paid off.

The September 1st deadline was rapidly approaching, the weather was closing in, and time was running out. The countdown to the first shot began.

CHAPTER 7

Earth in a Shroud

ANOTHER COLD AND ICY NIGHT IN THE TRACKLESS VOID OF THE SOUTH ATLANTIC. Somewhere in the darkness, a small group of men clad in heavy hooded parkas clustered around a missile launcher on the fantail of the USS *Norton Sound*, illuminated only by a set of makeshift floodlights mounted on poles. As they worked, a biting wind whipped around them, blowing snowflakes across the deck, whirling around the tall, thin missile resting on the launcher, and passing beyond into the inky blackness of the ocean.

Their preparations completed, they slowly, cautiously, began raising the missile to its fully upright launch position. As it rose, seeming to grow in stature against the dark skies, some of the men rested their gloved hands on guide ropes or the launcher frame, as if to urge the missile on, or perhaps, to reassure themselves. Atop the narrow structure of the missile, looking like the end of a Q-Tip, was an odd bulge: a small nuclear warhead.

Finally the men withdrew, leaving the Lockheed X-17a missile alone on the deck, standing in defiance of the choppy twenty-five-knot winds that occasionally shook it on its launch platform. Everyone knew those winds weren’t nearly strong enough to tip over the forty-foot, six-ton rocket with its nuclear warhead, much less the launch gantry. Or so they hoped.

Most of the ship’s crew, save for the launch technicians and a select few others, were below decks and behind closed hatches, their only connection with the event about to transpire consisting of terse announcements over the ship’s public address system. In the superstructure above deck, in the command spaces and telemetry room and radio shack, officers and sailors busied themselves watching instruments, staying in contact with the other ships and aircraft of the task force, and waiting.

The final command to fire the missile and send it on its spectacular one-way journey would come not from a human being, but from a machine. When the ship’s skipper, Captain Arthur Gralla, issued the order, an officer would press an “intent to launch” button that released control of the firing to an analog computer system tied into the gyroscopes deep within the *Norton Sound* that helped her navigate. Only when the constantly moving deck of the ship and the waiting missile atop it were at the properly determined angle would the Thiokol XM20 Sergeant solid-fuel first stage fire with its forty-eight thousand pounds of thrust and start the rocket on its way.

Gralla's command was accepted and executed at 0220 hours Greenwich Meridian Time on August 27, 1958. Even in the unsteady seas, everyone aboard felt the ship's stern momentarily drop with a shudder under the sudden thrust of the missile, the brilliant light of its first-stage engine revealing other vessels of the task force nearby. Then the ship steadied and the light congealed into a hurtling, glowing ball, followed by a mere point of bright light and then nothing at all, as the missile vanished into the heavy cloud layer above. In a few minutes, if all went well, the skies would be illuminated again by the detonation of the 1.7-kiloton warhead far above.

The missile technicians and the crew of the *Norton Sound* breathed a well-earned sigh of relief. Whatever else happened, the X-17a had been fired safely and successfully, and there was now one fewer atomic warhead on board. They had made some history: for the first time, an atomic ballistic missile had been fired from the deck of a ship at sea. Argus 1 was on schedule.

Unfortunately, it was not quite on target.

"There was something wrong, and we couldn't be sure just what it was," recalled Admiral Mustin. "The first thing we were sure of was that our calculations of the ballistic wind, and its effect on the weather cocking of the rocket, had been wrong. The rocket had not achieved a vertical trajectory." As the rocket climbed higher, tracking radars picked it up and calculated its course, and at least two of the S2F aircraft in the murky sky above the ocean had managed to see the rocket trail. The rocket was not about to fall back onto the task force or any other unsuspecting people on Earth, but it was quickly becoming apparent that it was not going to achieve its planned altitude.

Mustin initially suspected that the rocket's second stage had somehow failed to fire. Later analysis more or less concluded that a combination of the tricky, ever-shifting winds nudging the Argus 1 missile unpredictably, along with errors in the trajectory firing calculations, had resulted in an improper launching angle. It remained to be seen whether the final altitude of the warhead detonation would be enough to achieve the Argus effect and vindicate the predictions of the “Crazy Greek.”

The W-25 warhead dutifully exploded about seven minutes after departing the deck of the *Norton Sound*, at an altitude of about 110 miles and a position of 38.5 degrees south latitude and 11.5 degrees west longitude. The pilot of one of the S2F aircraft was flying at 22,000 feet and reported “a great luminous ball” about 40 degrees above the horizon. Back on the surface of the ocean, the few men standing outside on the *Norton Sound*, as well as a somewhat larger audience topside on the other task force vessels, saw the cloud layer above them glow brightly from horizon to horizon, flickering, then dimming. There was no sound save for the cold, howling winds.[1]

Those who saw the fireworks, such as they were, of Argus were fortunate. Particularly aboard the *Norton Sound*, most of the participants saw little or nothing of the fruits of their months-long work. “We opened the hatches,” recalled Quintin Owens, one of the tracking radar operators aboard the *Sound*. “The sky lit up brightly with a green tint.” Dick Culp didn’t even see that much, working in the telemetry station. Ken McMaster recalls watching the launch while standing in a hatch near the hangar door—“the noise and fire [were] frightening”—but he didn’t see the detonation at all.

At first, Argus 1 seemed to be pretty much a dud, at least scientifically speaking. The warhead had obviously detonated, but not at an optimal altitude, probably too low for any definitive results. But the visual observers, at least those who were airborne, certainly got their money’s worth. “For the next 30 minutes the aircrew observed and photographed an awesome auroral display as colors and shapes changed,” noted a government report.[2] The witnesses down at sea level weren’t as fortunate; the cloud cover prevented them from seeing much beyond the initial flash of the explosion.

Still, the presence of auroral phenomena was a good sign that something was going on up there. About an hour after detonation, the first of the Jason rockets was launched from Patrick Air Force Base at Cape Canaveral. In the ensuing hours, three more launch attempts were made from Patrick, Ramey, and Wallops, but only one was successful.

Martin Walt, a young physicist with Lockheed working under contract with the Air Force for the Argus project, was sitting in the telemetry center at the Cape, eyes glued to an oscilloscope, watching for signals from the radiation detectors aboard the rockets. “I watched intently during the 10-minute flights,” he recalled. Every one hundred seconds, he took readings and plotted the data, looking to confirm that the rocket had passed through the Argus band of electrons. “The results were disappointing as only the normal background had registered. At that point we ceased launching and reported that no significant effects had been seen”[3]—most likely because of the errant trajectory and relatively low altitude of Argus 1.

Those farther north in the Atlantic, up near the conjugate point in the Azores where the *Albemarle* was waiting, didn’t get to enjoy the show that the southern observers had witnessed. An Air Force C-97 observer plane reported an orange glow in the sky about twenty-two minutes after the detonation, and strong radar echoes were picked up by the *Albemarle* and other monitoring stations in the area, but no auroras or other visual fireworks were evident.

It took Explorer 4 to demonstrate conclusively that there was indeed an Argus effect. About three and a half hours after Argus 1, the satellite passed through the geographical region where the Argus radiation shell was expected to form. Sure enough, Van Allen’s instruments immediately began registering a sharp rise in electron flux, far above the natural background that had been carefully monitored and confirmed previously by Explorer 1 and over the past several weeks by Explorer 4. “The ‘Argus effect’ was easily and promptly observed,” Van Allen wrote later in a paper. “The great peak which was intersected at 0608 UT on August 27 had no precedent in four weeks of previous observations of the natural radiation. Moreover, it was encountered on the first observed intersection with the planned magnetic shell following the Argus I detonation.”[4] Repeated passes by Explorer 4 showed an electron shell extending and spreading, following the Earth’s natural magnetic field lines—just as Christofilos had predicted.

Still, it wasn’t much of a payoff, considering the enormous amount of effort that had been expended thus far on the entire project. Even if the first shot had been an unqualified success, another shot, which would provide more confirming data, would have been an irresistible proposition. Since the results of this first attempt had been rather equivocal at best, and since the *Norton Sound* was already in place with two more missiles and atomic warheads at the ready, not to mention the rest of the task force, why not try again? The powers-that-be certainly agreed. “Because of the negative results from other projects … headquarters concluded that a second shot was required,”[5] said an official history. Mustin recalled, “We told Washington …

we were getting ready to launch the second one."[6] In a terse cable to the Pentagon about Argus 1's faulty trajectory, he said, "Still seeking reasons."[7]

Because the *Albemarle* and other northerly-located forces hadn't seen much, the decision was made to change the launching site and thus the detonation point, which would move the all-important magnetic conjugate point farther north and hopefully closer to the Azores and the *Albemarle*. Mustin took his flotilla farther south, closer to the South Pole and into even colder, less hospitable seas. Sailors aboard the *Norton Sound* and the other vessels amused themselves by snapping pictures of passing icebergs.

Meanwhile, the Lockheed missile technicians checked and rechecked their charges. "These rockets were really just castoffs," Mustin noted. "They were the leftovers of an earlier phase of the Polaris program, modified to our purpose." That was the reason for the "a" part of their X-17a designation. "The main thing to calculate was how far off the vertical must we launch this thing so that it would fly a vertical track."[8] Nobody wanted another wonky trajectory, as with the first shot.

By the night of August 29, everyone was on station. The S2F planes were once again aloft, flying their observation box pattern. The weather was once again marginal, with winds at twenty-two knots, but everyone was used to that by now. Unfortunately, at about quarter after ten that evening, the missile beacon system began to malfunction. By the time it was fixed, it was well after midnight. Finally, at 3:10 AM, Argus 2 left the deck of the *Norton Sound*.

This time, things looked better. "We were satisfied that it had gone vertical," Mustin said. "Everybody in the planes caught it right where it ought to be, as it came up … and our radar plots showed it going vertical."[9]

The trajectory was good. Then a different problem: once again, the missile was not reaching proper altitude. "They saw the second stage ignite, but they didn't see the third stage," Mustin said.[10] Several minutes later, the sky again lit up from horizon to horizon as the warhead detonated. Except for the aircrews, however, the light show was more disappointing than with the first shot, not only for Mustin and his South Atlantic forces but also for the *Albemarle* up north, again thanks to heavy cloud cover. Neither the observer aircraft nor the radar stations in the North Atlantic detected much, if anything, from Argus 2. No aurora, no glow in the sky, no doubt to their considerable disappointment.

The Jason team was considerably more successful, however. This time, they managed to successfully launch ten out of twelve rockets, beginning just under half an hour after Argus 2 and continuing until about four days later. The readings from the rocket instruments provided a good picture of the Argus 2 radiation belt. “We all felt elated at that point,” Walt remembered.

And Explorer 4 came through again as well, although with a bit of confusion. The initial data reports seemed to be coming from an orbital position that should have coincided with the Argus 1 shot, not the Argus 2 event. Finally the analysts realized that Explorer 4’s course had shifted several minutes in latitude, throwing off the predictions. Compensating for the orbital shift solved the discrepancy; the Explorer data nicely complemented the Jason results as well. “The rocket instrumentation was more elaborate and gave the best determination of the energy spectrum of the electrons,” explained Walt.[11]

“But we hadn’t done what we set out to do, so we got the third rocket ready,” Mustin remembered.[12] The third and final Argus shot would prove to be the most memorable of them all.

MUSTIN AND THE REST OF TASK FORCE 88, NOT TO MENTION ALL THE OFFICIALS at the Pentagon and ARPA and Lawrence Livermore Laboratory and everyone else even tangentially aware of Argus, had done everything possible to maintain the most scrupulous security from the very beginnings of the enterprise. No less a personage than President Eisenhower himself had emphasized from the start that Argus had to remain top secret for reasons both military and political. Even by the time atomic warheads began exploding in the midwinter darkness over the South Atlantic, many of the participants in Argus, from the sailors at sea to technicians at ground observation posts and labs around the world, still had only a vague notion of what was really going on.

So confidence in the clandestine nature of the proceedings remained high. Even Frank Shelton, Argus technical director, was confident that it would be possible to “indefinitely maintain that [Argus] had never occurred.”[13]

Unfortunately, secrecy and security are concepts of the human mind, not the natural universe. As scientists such as Albert Einstein, J. Robert Oppenheimer, and their brethren throughout history have repeatedly warned those in power, the so-called “secrets” of nature are open to anyone and everyone who cares to discover them, whether they involve how to make a fire, carve a better arrowhead, or build an atomic bomb.

Van Allen’s discovery of the natural radiation belts girdling the Earth did more than simply galvanize Nicholas Christofilos into making Argus a reality. It also inspired countless other scientists around the world and aroused their scientific curiosity and inventiveness, getting them to ask questions and propose experiments to find answers. Among them were Edward Ney and Paul Kellogg, a pair of scientists from the University of Minnesota.

“Upon hearing of the Earth’s newly discovered trapped radiation in May 1958, [they] suggested that a nuclear device might be detonated some 250 miles high near the southern auroral zone to see what effect it might have on the radiation belt,” George Ludwig recounted.[14] There was no frantic talk about stopping Soviet missiles or defending the US from the Red hordes, or knocking out enemy satellites that might be spying on us or preparing to drop H-bombs on America from outer space. Ney and Kellogg were simply scientists, excited about a new discovery and eager to explore its nature and implications, for no motivation or purpose other than pure intellectual curiosity. “Those discussions took place in the absence of any knowledge by Ed or Paul of the Argus Project,” Ludwig emphasized.[15] Perhaps, thought Ney and Kellogg, the concept would be an interesting project for the ongoing International Geophysical Year, a way to extend Van Allen’s discovery into new areas of spaceflight and experimentation.

They took their idea to friends in Washington at the Office of Naval Research, the same folks who had been launching (or trying to launch) Vanguard satellites. The response was decidedly chilly. Cease and desist, the researchers were told in no uncertain terms—though they were not told why. Undeterred, Ney and Kellogg next decided to approach Herbert York at ARPA, but were firmly dissuaded from that notion as well.

Finally, they settled on the time-honored practice of all scientists: publishing in the open scientific literature, in this case, the venerable journal *Nature*. “When the Pentagon learned of that, their consternation changed to full-blown alarm,” wrote Ludwig.[16] Gently but firmly, Ney and Kellogg were persuaded to hold off on publishing their work. No, we can’t explain why, but you’ll find out soon enough.

However, Ney and Kellogg might have been spared some grief had anyone at the Pentagon or CIA pondered the universality of nature and the evanescence of supposed "secrets." Less than a year later, on March 8, 1959, two Russian scientists, I.S. Shklovskiy (who would later become famous for his ideas on extraterrestrial intelligence and his work with Carl Sagan) and V.I. Krasovskiy published an article in the Soviet newspaper *Izvestiya* reporting the detection of high-energy particles in the lower Van Allen belt—speculating that the phenomenon might be artificial. "It is not to be excluded that this zone has, if we may say so, an artificial origin," they wrote. "High-altitude explosions would be fully sufficient for the formation of the lower zone of fast charged particles."[17] In their article, the researchers referred to some of the recent US tests in Nevada that had been conducted from high towers or balloons.

Such musings by Soviet scientists did not, of course, mean that the USSR either knew anything about Argus or was plotting such experiments itself. But it's clear that Christofilos was hardly alone in his wild ideas of atomic bombs and radiation belts. "The idea of injecting charged particles into the Earth's magnetic field by nuclear detonations did, as it turned out, also occur independently to the Soviets," as Ludwig wrote. "It is unknown when the idea first occurred to them—it might have been either before or after they learned of our discovery of the region of high-intensity radiation."[18]

A survey of foreign scientific literature on ionospheric research conducted for the US Congress about ten years after Argus noted, "It would appear much more likely from subsequent Soviet articles, however, that not only the USSR, but other countries, had foreknowledge of the [Argus] tests and were monitoring them."[19] That was a thought that would certainly have given Admiral Mustin, Nicholas Christofilos, not to mention President Eisenhower, a severe case of insomnia. The report also noted that the worldwide monitoring efforts encouraged and supported by the IGY program would have made the conduct of secret nuclear tests such as Argus very difficult if not impossible, another thought of which the Argus people were already keenly and painfully aware.

While Admiral Mustin's patrolling S2F aircraft and destroyer screen kept away any nosy Soviet trawlers or submarines from the Argus operational area, the global nature of the Argus experiments and their effects couldn't be so easily contained. Ludwig observed that "The Soviets also had ample opportunity to see the results of the Argus tests by receiving the *Explorer IV* signals at their receiving stations. On one specific occasion, as *Explorer IV* was transiting one of the Argus-generated shells, it was easily within range of their Tashkent receiving station."[20] Even worse, it wasn't just the Russians: similar French geophysical stations also detected them.[21].

At the time, neither the Soviets nor the French quite realized yet just what their instruments had stumbled upon, nor would they know conclusively until several more months had passed. For the moment at least, only the privileged few who were privy to Argus knew precisely what was going on down in the South Atlantic.

CHAPTER 8

The Big Finish

IF ADMIRAL MUSTIN AND THE FOUR THOUSAND OFFICERS, SAILORS, TECHNICIANS, and assorted support personnel of Task Force 88 had any hopes of wrapping up their mission quickly and setting sail for home and the warmer climes of the northern hemisphere, they were soon disappointed. The grand finale of Argus—at least, the part involving rockets and atomic explosions—was going to take longer than planned, and for a reason that surprised absolutely no one: the South Atlantic weather.

The third Argus shot was set for two days after the second, on September 1st, just in time to fulfill the deadline set months before. That deadline had been mostly arbitrary, even though President Eisenhower had announced the successful conclusion of negotiations with the Soviet Union for a nuclear test moratorium just over a week earlier. Officially, however, that moratorium wouldn't go into effect until midnight on October 31st.

Technically speaking, then, the United States could go on detonating nuclear weapons until then, and in fact, the second phase of the HARDTACK test series was set to begin at the Nevada Test Site in only a couple of weeks. But even had Task Force 88 brought along enough X-17a rockets and atomic warheads to continue piercing the upper atmosphere and lighting up the sky, nobody wanted to hang around in the frigid, squally South Atlantic that long.

So everyone was quite anxious to see off *Norton Sound*'s final nuclear-tipped rocket as August ended and September began. Even the Pentagon couldn't help nudging Mustin along. "It is a real pleasure to observe how well all of you are doing a tough job," noted a cable to Mustin from AFSWP chief Admiral Parker back home in Washington. "A final good one to start September off would be wonderful."[1]

The South Atlantic had other ideas. The winds refused to let up, and launch preparations had to be scrubbed and the missile returned to the hangar. In search of better weather and also to perhaps move the magnetic conjugate point closer to the *Albemarle* up north, Mustin moved the task force farther southward, with the destroyer escort USS *Hammerberg* on weather picket duty about 250 miles west of the main force.

The Lockheed technicians again wheeled out the Argus 3 missile onto the *Norton Sound*'s fantail on September 5. The seas were rougher than ever, but still deemed within launch parameters, so the countdown proceeded. Finally, at around 10:30 that evening, Captain Gralla gave the order, the "intent to launch" button was pressed, and …

Nothing happened.

The Argus 3 missile sat calmly on its launcher, unmoving, unconcerned, as the South Atlantic winds blew and the *Norton Sound* pitched and rolled in the waves. By now, everyone was more or less used to the disconcerting experience of a slight delay after the launch was ordered, but this was taking too long.

"It was like 4, 5, 6 minutes gone by," Dick Culp recalled. "We were all sitting there thinking, okay, we've got a 2 kiloton nuclear warhead sitting on top of a three-stage rocket in the South Atlantic in a storm."[2] What was the best way to get the damn thing off the fantail without obliterating everyone within five miles?

Fortunately, that wasn't going to be necessary. Technicians quickly determined that the missile had simply failed to ignite—a common phenomenon in the rocket business, and something that was relatively easy to correct. The September 5 launch was officially scrubbed, the missile taken down, and corrective measures quickly applied. "One of the destroyers sent us a book of matches with a comment that maybe these would help," Keith Mayfield remembered. "That gave us all a good laugh."[3]

Twenty-four hours later, everyone was again in place, the sea conditions were unsurprisingly lousy, and the X-17a missile was ready. This time, no book of matches or any other extraordinary measures were required. At shortly after 10 PM, the button was pressed, the ship rolled, and the rocket launched.

Everything went precisely as planned. There were no trajectory problems, no glitches with the rocket staging, no other unforeseen difficulties. Even the skies cooperated, the cloud cover opening up in time for the *Norton Sound* and the other vessels of Task Force 88 to be rewarded with the sight of the Argus 3 warhead detonating at almost five hundred miles altitude. Following the explosion, they also watched as an artificial aurora formed, shimmering and coruscating in the night. Far to the north in the Azores, the *Albemarle* also reported seeing a brilliant auroral display, as well as detecting the predicted radio and radar effects. They had hit the magnetic conjugate point more or less dead on at last.

An observer watching from the fantail of the *Albemarle* vividly described the sight:

> The effect began as a blue-green ‘spear’ starting close to the horizon, climbing in back of a cloud, and reappearing above the cloud. The effect first appeared about a half a minute after detonation … a short time after the onset of the effect, a red crown developed at the head of the bluish spear. The red was distinct but not as bright as the green. For the next minute the red spread out while the blue-green lost intensity. The red aurora deepened in color, began to fade, and after 4 minutes was no longer visible. The blue-green spread out and became an indistinct luminous glow covering about 45 degrees of horizon up to about 30 degrees high. This glow slowly faded and was gone about 32 minutes after the aurora began. The brightest part of the initial display was extremely intense as the edges of the cloud which obscured the center of the display were outlined clearly, as if the moon were behind the cloud.[4]

The display witnessed by the Task Force 88 contingent down south was even more spectacular. The various observation aircraft reported “a bright diffused white light which lit up the sky,” followed by “a long streak in the sky … with a fish-tail or ‘X’ of electric-blue … extending southward with a brilliant magenta,” “pastel lines of blue, green, and rose,” and brilliant streamers of colored light against a background of stars, followed by auroras. Though no equally picturesque eyewitness descriptions seem to have survived from the shipboard audience, the light show they witnessed was undoubtedly no less spectacular.[5]

From its orbital vantage point, Explorer 4 was also suitably dazzled by Argus 3, observing the electron shell forming and spreading around the planet. It would provide the only space-based observations this time, as the sounding rockets of Project Jason remained grounded for the Argus finale.

“This one went completely as planned, in all respects,” Admiral Mustin later noted with satisfaction. “This was the beginnings of a whole new realm of nuclear effects knowledge.”[6]

Not to mention vindication for a “crazy” Greek-American physicist, who had just witnessed his nutty idea evolve from scorn and ridicule to a massively ambitious operation of the US military and scientific establishment, all in less than a year.

CONSIDERING THAT HE WAS THE MAN WHO HAD STARTED IT ALL, WHOSE RATHER outlandish idea had grown in less than a year from an off-the-cuff discussion in a Livermore office between himself and his bemused supervisor into a massive, globe-girdling operation involving thousands of people working in utmost secrecy, Nicholas Christofilos is curiously absent from almost all contemporaneous accounts of the Argus tests. Aside from AFSWP scientist Frank Shelton’s meeting with Christofilos at the Pentagon at the end of July 1958, Christofilos is unmentioned in the available records as a participant in any of the frantic activity that ensued over the following weeks. If he was indeed the man of the hour, the person who had posed the questions that so many people were now striving and risking their lives to answer, then just what had he been doing all this time?

Argus’s extreme secrecy, combined with the highly accelerated planning, scheduling, and execution of the entire operation, were not only unique for US nuclear test series but posed a frustrating problem for historians: the project didn’t generate the usual mountains of documentation typical of a huge joint governmental and military undertaking. Even the most comprehensive official history of Argus, the Defense Nuclear Agency report performed as part of the United States Atmospheric Nuclear Weapons Tests/Nuclear Test Personnel Review in 1982, noted this difficulty: “… a larger than normal amount of the planning and coordination was done in person, without the usual amount of formal preplanning, agenda preparation, and position papers being written.”[7]As if that weren’t enough, many of the records that did exist have been destroyed in routine housekeeping in subsequent years, while some, such as the small number of radiological film badges used by Task Force 88, have simply been lost. Still other records remain classified.

Which nevertheless does not preclude informed speculation on some matters, such as Nicholas Christofilos’s activities during the Argus shots and their immediate aftermath. He was certainly being consulted on occasion, as in his Pentagon meeting with Shelton, but undoubtedly spent most of the rest of August and September 1958 back at Livermore, concentrating mostly on the Astron project but keeping an ear to the ground for word from the South Atlantic. When the news finally came that his theories had been confirmed and a “Christofilos effect” had indeed been observed, one imagines him nodding in satisfaction, enormously pleased with himself—and not at all surprised. He had, after all, known all along.

And then he surely went right back to work, waiting for the data from Van Allen’s Explorer 4 and the various other scientific observations, his mind already churning with the possibilities of their application to Astron and ever more outlandish ideas. As always with an intellect such as Christofilos’s, answering one question only led to many more.

THEIR MISSION ACCOMPLISHED, THE MEN OF TASK FORCE 88 PREPARED TO SAIL for home, hearth, and family, with the crew of the *Norton Sound* perhaps especially relieved by the fact that they were no longer carrying live nuclear warheads along as part of their cargo. Though she had followed a solitary course on her outward bound journey from Port Hueneme, the *Sound* remained with her six other task force companion vessels for now, steaming northward toward the equator and the summer. Deciding that the men under his command had earned a break, Admiral Mustin requested and was granted permission to take his ships to Rio de Janeiro, from which the civilians from Lockheed and Sandia could leave the *Norton Sound* and fly home. Meanwhile, on the way, his aircraft carrier flagship USS *Tarawa* continued routine daily flight operations.

The mission may have been over, but not the secrecy. Except for official communications back home, radio contact with the outside world was still prohibited. “There was no noticeable effect on the morale of ship’s personnel,” said Mayfield. “We were sailors doing our job.” Still, noted *Norton Sound* petty officer Bobby Terrell, “We were told not to say anything to anybody about where we had been and what we did.”[8]

Which, of course, did not preclude speculation, especially once the sailors of Task Force 88 were set forth on liberty in Rio and began mixing with the civilian population. Even if the crew kept their mouths shut, such restrictions didn’t apply to non–US Navy personnel. Some of the wilder theories about the doings of the *Norton Sound* and Task Force 88 involved, predictably, the Russians. Although Sputnik 1 had long since fallen back to Earth in January, as had Sputnik 2 in April with its unfortunate canine passenger, Sputnik 3 was still beeping away happily as the Soviets' 1958 representative in Earth orbit. "Many people said that our mission was to target this satellite and shoot it down," recalled Quincy Owens. "Of course, this wasn't true." Still, not an unreasonable assumption to make concerning a guided missile ship operating in remote waters, far from established sealanes. But the only involvement of the *Norton Sound* with Sputnik 3 was an occasional sighting of the transiting satellite by ship's lookouts during those nights that were free of clouds and storm squalls.

As Dick Culp recalled, however, the *Norton Sound* did have an encounter with Sputnik 1 the previous year. "We were off of Central America, off of Panama basically, looking for some weather to test missiles in, and that was when Sputnik was launched. In the telemetry shack, we played around and we finally picked up the signal. We must have sat there for two hours, just listening to that damn thing go ping, ping, ping."[9]

Admiral Mustin took immediate steps to preserve the secrecy of Argus upon arrival of the task force in Rio on September 15. "As soon as I got in, I approached the local US security types in the embassy, who would have been CIA people, of course," he recounted. "We had in Brazil a rather numerous military mission, commanded by a rear admiral. And we had naval communications security, and so on. I told them what the problem was and alerted them. At the conclusion of our visit of about a week, more or less, there had been no talk in the bars or anywhere. Of the 4,500 men in the task force, the few who knew kept their mouths shut, and those who didn't know had been successfully diverted off to some other explanation of what was going on."[10]

Presumably, that explanation did not involve taking potshots at Sputnik 3. "We were told that it had something to do with the discovery of the Van Allen radiation belts," said Bobby Terrell.[11] (Which of course was technically true, if in an oblique manner.) As Mustin explained, "You never can get away with just telling people, 'Oh, we're doing something that's so secret we can't tell you.' That just gives rise to all kinds of speculations; you've got to give them some other explanation that's plausible." The missile firing drills and weather preoccupations of the task force suggested a reasonable cover: "some sort of high-altitude weather observations or something." It seemed to work, as Mustin recalled. "There was no leak from that task force picked up by security agents who were deliberately alerted to look for it."[12] Although, as the final official Argus report noted, "the press displayed keen interest," the official line that TF 88 had been "testing new antisubmarine-warfare and long-range communications equipment, taking upper-air soundings, and generally conducting operations normal to such a force" was readily accepted.[13] Operation Argus remained comfortably classified—for now.[14]

In any case, the sailors of Task Force 88 were far more interested in blowing off steam, meeting girls, and enjoying the back pay they had just received than in revealing secrets. They enjoyed their liberty blissfully unaware of being shadowed by security men ever vigilant for indiscretions. "Rio was a blast," said Ken McMaster. "We had lots of liberty and two months' pay in our pockets. The people were extremely friendly and helpful." Without going into detail, Bobby Terrell simply said, "I will always remember Rio."

Even Admiral Mustin called it "an absolutely delightful stay." Not only were there no security problems, there were none of the usual incidents routinely expected whenever a group of young sailors hits port after months at sea. Mustin noted, "When we left, the local provost marshal told me, 'Oh no, we didn't expect any trouble, because trouble always comes when sailors start to fight over a girl in a bar somewhere. But in Rio, there are so many more girls than there are sailors that they never have to fight over them. If there's any fighting, it's the girls fighting over the sailors.'"[15]

Finally the Rio excursion ended and the ships of Task Force 88 set sail for home. After crossing the Equator once more, the force began to break up, its individual vessels heading for their own home ports along the East Coast. The California-based *Norton Sound* was on her own again, stopping in Trinidad for a two-day visit before heading for the Panama Canal, the Pacific Ocean, and the final leg of her long trip home to Port Hueneme.

Mustin began to collect messages of congratulations from higher echelons. Chief of Naval Operations Admiral Arleigh Burke cabled,

> YOUR TASK FORCE HAS ESTABLISHED AN UNQUESTIONED RIGHT TO A PROMINENT PLACE AMONG THOSE WHO HAVE DEMONSTRATED TO THE FREE WORLD THAT IT MAY BE THANKFUL FOR THE CALIBER OF OFFICERS AND ENLISTED MEN IN OUR NAVY X TO ALL HANDS IN TASK FORCE

EIGHTY-EIGHT A MOST HEARTY WELL DONE.[16]

Now that the sailors, pilots, missilemen, radar operators, and all the other practical, nuts and bolts, hands-on participants of Operation Argus had essentially completed their work, the focus shifted back to the place where it had all began: the laboratories, the blackboards, and the restless minds of the scientists. There was a prodigious amount of Argus data to be reduced, examined, collated, interpreted, and analyzed. Much of it came from Explorer 4, and it went to the physics building in Iowa City, to be processed and parsed by James Van Allen and his stalwart graduate students. As expected, the satellite finally went dark in mid-September, its batteries exhausted, but it left reams of data as its legacy.

The pervasive secrecy of Argus proved inescapable. “As in the case of the earlier Explorers, paper strip-charts were produced as a first data reduction step for Explorer IV,” explained George Ludwig. “But for Explorer IV, the process was a bit more complicated because of the highly classified nature of the Argus Project.” Before the Argus tests, nothing was classified, but that changed quickly. “During the month following the first nuclear burst, i.e. during the times that portions of the data showed the effects of the tests, Carl McIlwain served as a data screener,” Ludwig noted. “He diverted the charts containing indications of the Argus tests for special handling, where he served as the primary data reader.”[17]

Those initial results were shared only with a highly select group of individuals within government and scientific circles. The intent was not merely to hide that the United States had just conducted three nuclear tests without the knowledge of the rest of the world. There was also the fact that those tests had been worldwide in their effects—and that the “Christofilos effect,” now also known as the “Argus effect,” had graduated from an intriguing hypothesis to scientific reality, with implications that ranged far beyond the scientific and academic into the military realm.

As Van Allen later wrote, “In each of the three cases, a well-defined … shell of artificially injected electrons was produced.” The Argus shell initially formed at the upper atmosphere detonation point, with electrons zipping back and forth from magnetic pole to magnetic pole, then steadily progressed eastward, just as Christofilos had theorized. For those worried about Soviet skullduggery, Argus also provided some welcome reassurance: “Also, we found that the physical nature of the Argus radiation, as characterized by our four Explorer IV detectors, was quite different than that of the pre-Argus radiation, thus dispelling the suspicion that the radiation observed by Explorers I and III had originated from Soviet nuclear bomb bursts."[18]

But the good news was also tempered with some bad. Although the Christofilos effect was real, it also proved exceedingly weak. The Argus electron shells persisted no longer than a few weeks, and not very intensely at that. It seemed unlikely that Christofilos's "radiation shield" would even inconvenience incoming Soviet warheads, much less completely incapacitate them. There might be some effect on satellites that happened to pass through, but even that would be limited and slight.

Initial disappointment in some quarters, however, soon yielded to a renewed enthusiasm. Of course the Argus effects were modest, argued some. It was only a proof-of-concept thing, after all. The warheads were barely firecrackers, not even two kilotons, and aside from the third shot, they hadn't even really gone off at a properly high altitude. But what would happen if we got serious: detonating a thermonuclear weapon hundreds or even thousands of miles up, pumping megatons, not mere kilotons, into the magnetosphere? Wouldn't that give us our missile-killing radiation zone? Proponents of the notion even had a code name picked out for a repeat performance of Argus at the megaton scale: Willow-Argus.

Such ideas might have seemed attractive and even sensible to some in the Pentagon, but any serious proposals along such lines were quickly squelched. With the impending nuclear moratorium at midnight on Halloween, there would be no more plans for nuclear tests in the immediate future. The HARDTACK series was wrapping up in Nevada, but it was far too late to make any such grandiose changes in its schedule to sneak any Argus-type experiments under the wire. And megaton-range tests were out of the question anywhere except the distant Pacific test site.

As the Iowa team continued to study Explorer 4 data, the Project Jason and Midas teams performed their own analyses of the information collected from the sounding rockets, aircraft, ships, ground stations, and radar and radio observations. By the beginning of November, even as the analyses and head-scratching over Argus data continued, enough had been pieced together for presidential scientific advisor James Killian to report preliminary results of Argus to President Eisenhower in a detailed memo on November 3.

Significantly, Killian concentrated his emphasis on the military aspects of Argus, not the scientific. "This historic experiment, probably the most spectacular ever conducted, provides the first verification of the existence of several phenomena of military importance when a nuclear explosion takes place in space above the earth's atmosphere," he wrote. "The results yielded by the experiment verified and confirmed the earlier predictions. They affect the design requirements for the electronic and warhead components of intercontinental and intermediate range ballistic missiles, the design of ballistic missile and air defense radar equipment, and, especially, military short wave communications equipment."[19] Already, Killian was thinking ahead to the implications for America's ongoing ICBM programs.

Still, in keeping with his official role, Killian mentioned the scientific value of Argus, even as that was still being determined by Van Allen and the various other researchers involved. "The experiment bore out the theoretical predictions of Christofilos in a beautiful manner," Killian waxed enthusiastically, "and provided scientific information of great value about conditions surrounding the earth." Though he didn't mention it in his memo to Eisenhower, Killian was also quite aware that the new detail provided by Argus on the space environment and radiation conditions was going to be vital for the nascent manned space effort.

Killian also praised the "extraordinary accomplishment" of all involved. "Especially notable was the successful launching of a large solid-fuel rocket carrying a nuclear payload from the heaving deck of a ship in the squally South Atlantic. Scarcely less so is the fact that the whole experiment was planned and carried to a completely successful conclusion in less than five months."

On top of all that, noted Killian, "Impressive, too, is the fact that no leaks have occurred despite the large number of civilian and military personnel involved."[20]

Unfortunately, though neither Killian, Eisenhower, nor most anyone else concerned with Argus knew it at the time, the leak had already occurred, and would soon burst forth into a flood.

CHAPTER 9

The Veil of Secrecy

GIVEN HIS WARTIME NAVY SERVICE FOLLOWED BY YEARS OF SCIENTIFIC WORK using military resources, James Van Allen was no stranger to the peculiar world of official secrecy and classification. But there was always a fundamental tension there, between the requirements of secrecy and his identity as a scientist dedicated to the principles and long-standing scientific traditions of open research and freedom of knowledge. Most of the time, he had been content to walk that sometimes shifting line, reasoning that he was working with the military, not for it; under its tent, perhaps, but not under its thumb.

Now that reasoning was beginning to feel somewhat hollow, and the continued restrictions on Argus and his Explorer 4 results were beginning to chafe. He could understand perfectly why Argus had to be kept secret beforehand, and during the actual nuclear shots. But that was all over with now; mission accomplished, the job done. What possible justification, he began to ask, was there to keep everything in the dark indefinitely?

There were other considerations besides basic principles. Explorer 4 had been publicly planned, announced, and conducted as a part of the International Geophysical Year. The IGY's raison d'etre was that it was completely public and international. All data was to be gathered by the sixty-seven participating nations in a spirit of complete scientific openness and collegiality. That meant all was to be shared freely. The IGY was supposed to represent the nations of the earth coming together in peace and friendship to explore and study the planet that they all shared in kind. Including even the USSR, and of course, the United States.

So all of the data collected by Explorer 4, as an IGY project, had to be shared with the world. There had to be time allowed to collate and analyze and interpret, but eventually, the data had to be made public. It was more than just a matter of scientific principle and cooperation—the US had signed an international agreement to that effect. If they held something back, if they refused to share some of their findings, then they were not only breaking that agreement, but everyone—most particularly, the USSR—would wonder just what the hell the US was hiding, and why.

This had been a topic of some concern from the very beginnings of Argus. A few of the scientists involved, such as Herbert York at ARPA, had pointed out the IGY issue, something which became even more of a problem with the necessity of borrowing (or perhaps, commandeering) various IGY equipment and resources for Argus in order to maintain the impossibly tight project deadline. That problem directly conflicted with another: the need to keep Argus hushed up so as not to endanger the ongoing negotiations for a test ban treaty or at least the prospects for a moratorium.

At first, such concerns were briefly considered and then mostly brushed aside, under the pressures of time and planning for Argus. But now that the operation had been successfully accomplished, the missiles fired, warheads detonated, data collected, and everyone sent home (and the testing moratorium safely in place for the moment), the questions arose anew, and at a greater volume than before.

As far as the Pentagon and the military were concerned, there was nothing to talk about. They were perfectly happy to keep Argus under wraps indefinitely. “The satellite instrumentation records that disclose the Christofilos effect are classified and are not being made available to International Geophysical Year authorities,” stated the Navy’s final Argus report from Task Force 88, and that was that.[1]

The problem was that events were transpiring to make such a position difficult to sustain, if not ultimately impossible. Not only were pesky scientists such as Van Allen pushing for more openness, so were others in government, including members of the President’s Science Advisory Committee (PSAC). As 1958 transitioned into 1959, the Argus secrecy that had been simmering along contentedly in a slow, rolling boil was threatening to boil over.

“A great debate within government developed as to what kind of public announcement should be made, if any,” Killian recalled. “There was a tricky question involved related to the International Geophysical Year because some of the data-gathering facilities that were employed were IGY facilities, and there was a general IGY commitment to publish the data from work done under the program … while recognizing that there were important military uses for the data yielded by the experiment and that this information should be kept secret, nevertheless there were strong convictions in PSAC that the experiment should be made public and such results as could appropriately be published should be made available for the benefit of the scientific community."[2]

That community was already quite restless, both in and out of government. So were several members of the fourth estate, who, though so far unbeknownst to Killian or most anyone else in scientific or government circles, were already quite aware of the Argus saga.

Hanson Baldwin, longtime military correspondent for the *New York Times*, had found out about Argus at least several weeks before any missiles had left the deck of the *Norton Sound* in August 1958. Apparently the leak originated with someone from James Van Allen's lab back in Iowa. Possibly a graduate student, possibly a technician—the identity of Argus's own whistleblower has never been definitively ascertained, even after six decades. (Killian's successor as PSAC chairman, George Kistiakowsky, later noted in his diaries that "Roy Johnson of ARPA has investigated this leak and has definitely traced it to the No. 2 man in the Van Allen Laboratories," which would seem to indicate Carl McIlwain, though this is not confirmed.)[3]

Baldwin knew he had a big story, but as a Pulitzer Prize–winning war correspondent, graduate of Annapolis, and savvy observer of all things military, he knew the serious ramifications of revealing such a secret operation, especially before it even happened, not only for the military but for the delicate test-ban negotiations ongoing in Geneva. He decided he needed some guidance on the scientific aspects of it all, so he confided in his *Times* colleague, science reporter Walter Sullivan.

"About the end of June, 1958, [Baldwin] put his head in my office and asked if he could talk to me privately for a few minutes," Sullivan later wrote in his book-length account of the IGY, *Assault On the Unknown*. "He had learned, he said, that the United States planned to fire several atomic bombs in space."[4]

Baldwin explained his reluctance about going public too soon. In the meantime, Sullivan suggested consulting a friend of his who was "so centrally involved in the United States space program that he would be sure to know of the operation." That was Richard Porter, chairman of the IGY Panel on Rockets and Satellites. Sullivan was sure that Porter would also "give us his candid personal opinion, rather than merely an official line."[5]

Porter was “both horrified and amused” when Sullivan told him what he and Baldwin had already uncovered. “I can’t tell you not to print it, but I can say this: If you do, the operation will never take place,” he told the science reporter.

To emphasize the point, about an hour later Sullivan got a call from ARPA’s head of security, William H. Godel, imploring him to hold the story. Sullivan assured the nervous security chief that he and Baldwin had already resolved not to publish anything before the Argus operation actually took place, which seemed to calm Godel for the moment. In exchange, they had ARPA’s assurance that Argus would be officially announced and revealed to the world after it was all over, and that the *Times* would be informed in advance so they could be the first to break the story.

Realizing that they’d obviously struck a very sensitive nerve somewhere within the bowels of the Pentagon, Sullivan and Baldwin agreed to sit on the story—for the time being. Which didn’t, of course, preclude further probings on their part, as they attempted to piece together their fragments of information into some sort of coherent whole.

Whatever his own misgivings about secrecy, Van Allen himself was as yet unaware of impending leaks. Aside from busily continuing to analyze the treasure trove of Explorer 4 data and preparing for new space missions, he had been busy helping to publicize the aspects of Explorer 4’s accomplishments that could be publicized. In the fall of 1958, he contacted several of the companies that had provided components of Explorer’s instruments, sending them photos of their contributions and granting them permission to use them in advertising materials.

“The enclosed photo shows a few of the 2N338, 2N335, and 608-C transistors and diodes employed in the Explorer IV satellite,” he wrote to electronics manufacturer Texas Instruments (TI) on October 22. “You are free to use this photo for publicity purposes, advertisements, etc., provided only that the State University of Iowa is mentioned in the release … Explorer IV was developed on an extremely tight schedule [Van Allen couldn’t reveal exactly why, of course] and we wish to express our appreciation for the cooperation received from you and your Company which enabled us to carry the project through to a successful conclusion.”[6] The company wasted no time in making good use of Van Allen’s offering, just a month later sending him a work-up of a full-page ad for the upcoming January issue of *Scientific American* mentioning the “added reliability and economy” of “TI transistors for Explorer IV.” Noted the cover letter, “Please note that credit for the photo is being given to your fine university in the ad.”[7]

Slowly but inevitably, the dark curtain of secrecy and security cloaking Argus wore thin. By the end of 1958, it had become little more than a veil, concealing details but not the general outlines of its subject. And to their increasing alarm, Baldwin and Sullivan began to feel their exclusive scoop beginning to slip away.

Much to Sullivan’s chagrin, in October 1958, the man who started it all, Nick Christofilos, presented his ideas of creating an artificial radiation belt of electrons around the Earth at the Chicago meeting of the American Physical Society. “The only major point he omitted was the use of an atomic bomb to provide the electrons,” Sullivan later complained.[8] Instead, Christofilos proposed the rather outlandish idea of generating the electron shield with an orbiting nuclear accelerator, something like what he’d been working on at Brookhaven and then at Livermore labs. Perhaps because he already had a well-established reputation for engagingly bizarre ideas, no one seemed to take special notice. Of course, Christofilos neglected to mention that what he was proposing in theory had already been proven in fact experimentally over the South Atlantic several months earlier.

Then came the annual meeting of the American Association for the Advancement of Science (AAAS) in Washington, D.C., just after Christmas, which Sullivan duly attended as part of his usual *Times* science beat. At the meeting came more rumblings of Argus from other quarters, including a paper presented by noted astronomer Fred Singer on “Artificial Modification of the Earth’s Radiation Belt,” and a press conference with Singer and James Van Allen. A *Newsweek* reporter kept asking Van Allen and Singer about any possible connections between the radiation belts and high-altitude nuclear explosions, such as the HARDTACK tests that had occurred that summer, and whether Van Allen’s Explorer 4 had detected them. Sullivan realized that his *Newsweek* colleague was really asking about Argus, albeit indirectly and perhaps somewhat shooting in the dark.

Old pros that they were, Sullivan and Baldwin realized that journalistically speaking, if other reporters had caught the scent, then the game was almost up. They decided to take more decisive action in order to guarantee an exclusive for the *Times*. Sullivan wrote to Herbert York, who had just been promoted from ARPA Chief Scientist to the Director of Defense Research and Engineering at the Pentagon. Sullivan mentioned to York some, but not all, of what he knew of Argus, and requested a meeting to discuss going public, emphasizing that the *Times* didn't believe it could continue to hold the secret indefinitely. "Because IGY data was open to all, I said that we—or anyone else—could unearth the Argus effect with a certain amount of 'concentrated effort'," Sullivan recalled.[9]

That was enough to set off some alarms at the White House and Pentagon. York consulted with James Killian, noting "I know that he [Sullivan] knows considerably more than he has written." He also pointed out to Killian that while the AEC wanted to keep the secret, scientists such as Van Allen were increasingly pressing for publication of Argus scientific data, as required by IGY agreements.[10]

To help prove his point that Argus could be uncovered with a little "concentrated effort," Sullivan checked with the IGY monitoring networks and casually inquired whether there had been any indications of unusual magnetic storms around the end of August and beginning of September. He was informed that yes, there had in fact been a "rather remarkable event" around that time that couldn't be associated with any definite solar disturbance of the sort that generally created such phenomena. Sullivan also checked around with other official sources, including overseas, for reports of unusual magnetic or auroral activity around that same time period. He detailed his poking around in another letter to York.

In a meeting at the Pentagon with York and his assistant on January 14, Sullivan laid out the case for going public. "They had studied my letters and apparently had discussed them with James Killian," said Sullivan. But they thought that the evidence Sullivan and Baldwin had collected was "inconclusive." Sullivan argued that since knowledge of the radiation belts and ideas for Argus-type experiments were already quite public, any disclosure of the Argus shots wouldn't tell the Russians anything they didn't already know. York agreed in a general sense, but pointed out that information on the explosions, such as their altitude, yield, and geographic location, was indeed sensitive and had to be concealed for national security reasons, and again officially asked the *Times* to hold the story.

As York later remembered: "In the first week of January 1959, on my first or second day on the job as director of defense research and engineering, he [Sullivan] came to my office and tried to strike a bargain. We will, he said, hold the story indefinitely if you will promise to give us twenty-four-hours' notice of any release on this subject. I was totally inexperienced in such matters, so I immediately reported the whole thing to Quarles and Killian. They rejected his proposal. The White House joined the Pentagon in trying to persuade the *New York Times* to suppress the story."[11]

Sullivan was far from satisfied by the entire encounter, suspecting that the real reason the Pentagon wanted Argus kept secret was political. "I am convinced that the only reason we are being discouraged by the Pentagon … is to postpone the day of diplomatic reckoning," he told Baldwin.[12] Specifically, he thought that with the test-ban negotiations still ongoing in Geneva, the last thing the government wanted was to reveal that the US had been secretly blowing up atomic bombs in space. Scientists involved with Argus had been telling Sullivan the same thing.

There was indeed a rapidly growing rift between the scientists pushing for declassification and openness on one hand, and the Pentagon striving to maintain secrecy on the other. It had been inevitable from the beginning, as soon as Argus planners hitched their star and their A-bombs to the IGY wagon in the frantic rush to save time and complete Argus as soon as possible. Reluctantly, and under the relentless prodding of journalists such as Sullivan and scientists such as Van Allen, the administration and the Pentagon were beginning to realize and accept the reality that they couldn't keep Argus secret forever. But if they couldn't, how best to limit the damage, and just how should they go about telling the world?

A memo to Killian on January 14, the same day as York's meeting with Sullivan, noted that "it is to be expected that fragmentary unauthorized releases and leaks will occur," and that "enough have already occurred to have attracted the curiosity of many scientists." Declassification "would have beneficial effects on our own scientific community since it would equip them with working knowledge and would stimulate them to develop new ideas and inventions based upon the newly demonstrated effects." In other words, it might encourage the development of new weapons or defenses based on the Argus effect, not to mention saving money by, for example, not building radio equipment susceptible to interference from Argus-type effects.[13]

Aside from coalescing around military and scientific poles, the intramural debate began to settle down into two broad options, which were set out by Presidential Special Assistant Karl G. Harr to Killian in a memo on January

20. “There appear to be two contingencies: first, the publishing of information about the shots as a result of leaks and, second, the voluntary release of information by the Government … If the *New York Times*, or anyone else, breaks a substantial part of the story, our alternatives appear to be: 1. Neither to confirm nor to deny such leaks; 2. To disclose all that we may safely do from a national security point of view.” Harr pointed out that waiting for the story to break on its own would mean that “we would have lost control over the manner and timing of such release.” He proceeded to recommend, among other things, that “appropriate scientists prepare a report” and that Congress and the appropriate foreign powers, including the Soviets, be officially informed as well. He even provided a handy set of guidelines to govern such a public release, including emphasizing that “the detonations produced no radioactive fallout”; that “there was no violation of our IGY commitments” because unclassified satellite data had been released; and that “this was not the test of a weapon in the usual sense, but a scientific experiment.” The Administration and the Pentagon would find that last suggestion in particular quite handy over the coming few months.[14]

Sullivan and Baldwin as yet knew nothing of all the consternation they had caused within the hallowed halls of the White House and the Pentagon. As far as they were concerned, in the previous summer they had made a gentleman’s agreement to keep the secret of Argus until it was all over and made public, and now their reasonable expectations to at last publish the story were being summarily dismissed and endlessly delayed.

Sullivan decided that the time had come for a direct approach, one closer to the top. On February 2, James Killian happened to be in New York City to make a speech. Sullivan figured that was his chance.

After Killian finished his speech, wrote Sullivan, “I appeared on a dais with a letter in hand, summing up our case for publication.” He handed the sealed letter to Killian personally, making sure it wasn’t going to be intercepted and round-filed by some trusty assistant running interference for his boss.

As the banquet hall emptied after the speech, Killian and Sullivan took seats. Killian opened and read the letter as Sullivan waited.[15]

The letter patiently spelled out the *Times*’ position. “We were given repeated assurances that we would be given sufficient prior notice of any announcement so that we should be the first to publish it,” Sullivan had written. “To avoid inadvertent disclosure, knowledge of the project has been limited, on the *Times*, to Hanson Baldwin and myself.” Despite prior assurances, however, Sullivan noted that, apparently, “a policy decision was made some months ago not to make any disclosure about Argus.”

But that position, Sullivan argued, was no longer sustainable. He detailed the various reports on Argus effects that had come out in the scientific literature, not to mention “questions asked by science writers at the AAAS annual meeting” that “suggest that some of them are on the track of Argus.” Given all that, continued the letter, “we doubt that we can continue to withhold publication of at least a limited account of Argus.” Scientists they had consulted were unanimous that revealing Argus “would not disclose anything which was not already known, from the scientific and military point of view.” And Sullivan again pointed out the US obligation to publish Explorer 4’s IGY data.[16]

Killian didn’t argue with Sullivan’s reasoning, but sidestepped it by pointing out that disclosure of Argus could derail the Geneva test-ban negotiations. “The Russians would be handed the argument that the only untrustworthy participant in the talks was the one that had sneaked off to fire atomic bombs far from its own shores,” as Sullivan paraphrased him. When Killian said that he also couldn’t provide any advance notice in case the government went public, Sullivan asked if at least someone could tip off the *Times* informally. “His reaction to this seemed to be assent, but we were still left in an uneasy situation.”[17]

Providing still more ammunition for Sullivan’s position was a short article published in a British paper, *The Observer*, a couple of weeks later. Although it didn’t mention Argus specifically, and obviously the unidentified “scientific correspondent” who penned the piece had no knowledge of the project, the article, titled “Radiation Belt May Monitor A-Tests,” noted that “the newly-discovered belt of intense radiation surrounding the earth … may provide a new method of detecting high-altitude nuclear explosions.”[18] The piece cited the work of Kellogg and Ney at the University of Minnesota which had earlier caused such consternation in the US government. Finally, they had been allowed to publish in *Nature*, proposing “a scientifically controlled high-altitude nuclear explosion to test the accuracy of their assumptions.” Now a foreign newspaper was onto it. Even the most obtuse governmental official had to realize that this did not bode well for the continued secrecy of Argus.

But the scientists were getting restless as well. Later in February, a highly secret ten-day scientific meeting was convened at Lawrence Livermore Laboratory to talk over Argus results in detail. Along with the planned scientific discussions, a large part of the meeting ended up dealing with the question of Argus classification. According to George Ludwig, who attended along with Van Allen, "the arguments were, at times, heated."[19]

As a later summary to York described, the debate split fairly evenly between scientific and military arguments. The memo summarized the scientists' position as "the scientific value and possible scientific prestige associated with publication of full reports on the scientific aspects of this experiment outweigh national security advantages of continued security." It was perfectly possible, argued most of the scientists, to separate out all the scientific aspects from the few military-type secrets such as the exact shot yield and firing locations.

Advocates of the "military" position, which turned out to be a decided minority, claimed that "the general national security value of the experiment outweighs the scientific and possible scientific prestige value to the country to be gained by release. Maintain necessary security. The impact on future military applications and implications may be larger than scientific or other values to be gained by open publication."

After hammering out the wording of these two propositions at great length, the group decided to vote for either "Proposition 1" (the scientific viewpoint) or "Proposition 2" (the military viewpoint). Not surprisingly, most of the scientists, including Van Allen's group, favored Proposition 1, which got seventeen votes to Proposition 2's five. Even the usually militaristic Edward Teller voted for open disclosure and Proposition 1. Only Nick Christofilos, always the gadfly, decided that he didn't quite like the wording of Proposition 1 but would vote for "a slight modification or reinterpretation" that he would write himself later.[20]

Van Allen felt strongly enough about the whole issue that, shortly after the Livermore conference, he sent an extended summary of his own views to Killian, using his unique preeminence within the scientific community to further emphasize and detail the virtues of openness. "Prompt and full public report of the tests and observations will contribute greatly to the international prestige of the United States as a leader in the application of atomic devices to scientific purposes," he wrote.

"The possibility of conducting Argus-type experiments has been suggested publicly by a number of persons both in the United States and abroad," Van Allen pointed out, noting that the existence and character of the Earth's natural radiation belt were already widely known, including by the Soviets, who were perfectly capable of carrying out similar experiments. "It may reasonably be presumed that they are already preparing such experiments, if indeed they have not already conducted them," he said.

And because the successful Argus tests "undoubtedly constitute the greatest geophysical experiment ever conducted by man," trumpeting that success to the world would "contribute enormously to the international prestige of the United States as a leader in scientific endeavor." Otherwise, he warned, "the US will quite likely be again 'Sputniked' in the eyes of the world by the Soviets."[21]

Now that the Argus team had come down on the side of publication, it remained only for Killian's PSAC to make their own judgment. At their monthly meeting on March 16, PSAC decided that "continued security classification … is not of significant military advantage to the US." While PSAC had originally recommended that Argus be classified Top Secret, "there are no longer any scientific or technical considerations which can justify the continued classification of the FLORAL [Argus] tests."[22] PSAC also reiterated the argument that revealing Argus would enhance American prestige and thereby offset any political fallout that might result from inadvertent leaks. The upcoming meeting of the National Academy of Sciences in April would be the perfect venue to tell the world about Argus, thought PSAC.[23]

The participants in all this debate and discussion were fully aware that the *New York Times* was lurking in the wings, straining at the bit to publish the whole story but patiently awaiting some stamp of official approval. But they weren't going to wait forever, particularly when Hanson Baldwin got wind of the rapidly building momentum within the government and even the Pentagon to go public. After being so patient and conciliatory for almost a year now, it seemed that Baldwin, Sullivan, and the *New York Times* were about to be scooped by their own government. "We feared that, once the decision was made in Washington, the machinery might move so fast that we would be left hanging in the dust," wrote Sullivan.[24]

If that was the case, then it was pointless to sit on the story any longer. Baldwin and Sullivan went to the top: *New York Times* publisher Arthur Hays Sulzberger, president Orvil E. Dryfoos, and managing editor Turner Catledge. After hearing the case laid out for them by their long-suffering reporters, the *Times* brain trust gave the go-ahead for publication—with the proviso that Sullivan and Baldwin notify the White House first as a courtesy. If the White House protested that publication would seriously harm national security, the *Times* would continue to hold off.

Around 4 PM on March 18, Sullivan tried to call Killian, but the science advisor was out of the office. Sullivan laid out the situation for Killian's assistant, R.M. Briber. "He said that matters had proceeded too far to withhold publication of the story any longer," Briber wrote in a memo. "When I asked if this was an irrevocable decision, he said that it had certainly proceeded far enough to make such a change very difficult; that it was essentially irreversible." Sullivan promised "to keep the yield, time, place, and height of the experiment in vague terms."[25]

Baldwin called ARPA and spoke to its director, Roy Johnson, basically giving him the same pitch: the *Times* was about to publish. "After Johnson hung up with Baldwin," wrote historian Lisa Mundey, "he immediately informed Deputy Secretary [of Defense] Donald Quarles of the conversation. Soon after, phones rang across Washington, as news of the impending story spread through agency circles. Before long, nearly every top official involved in Operation Argus in the White House, DOD, and AEC knew that a very public security breach was imminent."[26] The administration began to circle the wagons, deciding who would be responsible in which agency for answering what questions, and in general deciding on the officially approved story. Everyone settled in to await the coming onslaught.

Sullivan and Baldwin spent the rest of the evening scrambling to write the main Argus story along with supplemental material, and to prepare accompanying maps, photographs, and diagrams, all while waiting for a fateful call from the White House that could yet stop everything dead. "Hanson and I watched the clock tick away the final minutes until the great presses in the basement began to thunder. They rolled. No call ever came. And the world learned of Argus."[27]

Much to the relief of Sullivan, Baldwin, and a great many scientists including James Van Allen, the White House for whatever reasons had apparently decided to bow to the inevitability of the free press and the might of the *New York Times*. On the morning of March 19, 1959, one of the greatest secrets of the Cold War became one of its biggest stories.

CHAPTER 10

The Cold Glare of Day

PRESIDENT DWIGHT D. EISENHOWER WAS DECIDEDLY ANNOYED ON THE MORNING of March 19, 1959. The Argus story was emblazoned across the front page of the *New York Times*: “US ATOM BLASTS 300 MILES UP MAR RADAR, SNAG MISSILE PLAN; CALLED ‘GREATEST EXPERIMENT’.” Finding a top secret US military project all over the most prominent newspaper in the world was not the sort of thing a president wanted accompanying his morning coffee.

On the *Times* front page, as befitted their journalistic roles, Baldwin covered the military/operational side of Argus while Sullivan handled the science. Though they were working from incomplete information and were missing some pieces of the story here and there, they still managed to get most of the details right, and definitely succeeded in conveying both the scale and the significance of Argus.

“In a military sense the findings have great potential significance to the development of an anti-ballistic missile system and to the security of the nation’s early warning and global communications system,” wrote Baldwin. He described the role of Explorer 4 in studying the Argus effect and the failure of Explorer 5, noting that “partly because of the lack of adequate instrumentation and the complex nature of the experiment there is considerable controversy among scientists and military experts as to the exact interpretation of the data available. Nearly all agree, however, that the information … is still imprecise and that more experiments are needed.”

Baldwin also discussed the military implications of high-altitude nuclear explosions interfering with radio and radar, and the original Christofilos notion that “neutrons released by an exploding nuclear warhead from an intercepting missile could cause the detonation of an incoming enemy warhead—without actual physical contact between the missiles.” And he considered what Argus might mean for the ongoing test-ban negotiations: “If high-altitude tests can go undetected, as Argus did, there is apparently a substantial argument in favor of those scientists who hold that no monitoring system can possibly detect all test violations."[1]

Sullivan's story on the other side of Page 1 concentrated more on physics and the scientists involved. "It has been said that geophysics is a science 'in which the earth is the laboratory and nature conducts the experiments.' In this case the space surrounding the planet was the laboratory, but the experiment was conducted by man." He described the Argus auroras and the radiation shell resulting from the detonations, noting that "although the lifetime of the man-made shell of radiation has been kept secret, it is reported to have been limited." Sullivan also detailed how Christofilos had conceived of the Argus effect and the role of Van Allen and his Explorer 4 instruments, along with the detection of Argus phenomena reported by various IGY stations, noting that "although the results of Argus are still secret … they appear to have been world-wide."

Sullivan included another rather alarming idea in his story. "Some physicists would like to see a 'ladder' of nuclear explosions, climbing into space in a manner that would disclose the patterns of magnetism and other phenomena in the entire region lying within 15,000 miles of the earth," he wrote. But, he added, "In view of the present stalemate on suspension of nuclear weapons tests, further explosions in space would raise political problems."[2]

The *Times* also featured additional stories on "volatile scientist" Nicholas Christofilos, the Argus secrecy debate, and diagrams, maps, and photos of the *Norton Sound* and key personnel. It was impressively comprehensive coverage, and this was only the first day. More Argus stories would follow the next day and in the coming weeks, not only in the *Times* but in various other newspapers and magazines.

Even though the administration had known the security lid was about to be blown off, it was still something of a nightmare. Eisenhower's assistant, Brigadier General Andrew J. Goodpaster, explained to the president what had happened and the steps being taken to best control the damage. Herbert York would handle any inquiries directed to the Pentagon and "confirm that tests were held for the dual purpose of testing important scientific theories … and ascertaining other high altitude weapons effects of military interest," which, of course, had to remain classified. Meanwhile the AEC would confirm that three high-altitude nuclear tests had indeed been conducted in the South

Atlantic, but that there had been no significant fallout. If anyone asked why they had waited so long after the tests to announce them, the answer would be that they had needed to complete data analysis and evaluate military factors before any public announcement could be made.

Eisenhower was only partially placated by the efficiency of his underlings. “The President commented with vehemence upon the action of the *New York Times* in breaking security on this matter, and upon the irresponsibility of participants in the operation who leaked the information,” Goodpaster impassively noted in a memo. Later that morning, meeting again with Goodpaster and now joined by Killian, Eisenhower had calmed down, agreeing that a statement could be issued noting that “it had already been planned to hold a symposium on those scientific aspects of the project which did not have military implications.” He also put Killian in charge of handling all news inquiries on the scientific aspects of Argus.[3] Killian decided what could be revealed and what couldn’t, separating the Argus scientific wheat from the military chaff.

Meanwhile, it was time for the administration to face the press directly. At 11 AM at the Pentagon, Deputy Secretary of Defense Donald Quarles held a press conference, joined by York, ARPA Director Roy Johnson, and Argus scientists Frank Shelton and William Thaler. They were not facing a friendly audience.

As Sullivan later noted, for Quarles it was “probably the most discomfiting press conference of his career.”[4] The Deputy Secretary had to walk a fine line between the appearance of openness and the needs of security, and he had to do it before a roomful of skeptical reporters. He stuck to what had become the official line from the DOD and White House: “Like all programs where we are probing space and science in this area, we see the potentiality of military implications; but the program, the experiments as conducted were essentially in the spirit of scientific experiments.” Quarles made sure to emphasize the IGY connection and to assure all present that scientific data would be released as IGY rules required.

Predictably, the reporters were not satisfied. Quarles easily fended off questions about the yield of the Argus shots as classified, and in any case “the yields in these explosions are not part of the International Geophysical Year experimentation.” That didn’t stop further questions about the military side of Argus. Another reporter inquired whether Argus was “directly involved in the antimissile program.”

Quarles deflected further queries about the relevance of Argus for missile defense systems then under development, sticking to the emphasis on the science angle. He announced that because the National Academy of Sciences would soon be publishing all the scientific data officially, he would have to “reserve the answers to questions of that kind for the scientific publications.”

“Are we to infer from your remarks that all of this information is being withheld from the public by the National Academy of Sciences?” asked someone.

Of course not, replied Quarles. “What I said is that the National Academy of Sciences is organizing for the publication through normal scientific channels … I did not mean to imply that everything we know is going to be published, nor did I mean to imply that the National Academy of Sciences is holding up everything we know from publication.”

That didn’t sit well with the press. “Well now, Mr. Quarles, let me get this straight,” challenged another reporter. “Were these experiments not financed by the American people at taxpayer expense, and if this is true do the results not belong to the American people rather than the property of the scientists?”

“The results are not the property of the scientists,” Quarles retorted. “Of course the scientists publish those things which we collectively judge to be in the interest of the American people to publish. There is no inherent right of publication, and in fact, the public interest will prevail in deciding what will be published and what will not be published … I think it would be inappropriate for me or my associates here to attempt to even brief for you the scientific results.”

The press tried a different tack: Well, in that case, how about some broad information in layman’s terms? In response, Quarles let York answer some general questions about the Argus effect and its measurements through Explorer 4 and sounding rockets.

The press conference was becoming something of a Mexican standoff by this point. Another reporter inquired that if Argus really was intended as a scientific experiment, and given the public’s great interest in science, “Why can we not just have a general briefing right now explaining the general results of this? We are fairly intelligible *[sic]* men, Mr. Quarles, and we can convey this in turn to the American people”—most of whom, he noted, did not read relatively obscure scientific journals. (“Hear, hear!” someone added.)

Quarles continued to walk the line. “I would like to make it clear that we do not represent this to be solely a scientific experiment any more than the first reactor that went critical near Chicago was solely a scientific experiment. The scientific aspects of it were exceedingly important, but there were other aspects of it that were exceedingly important.” And not open for public discussion, in other words.

“Sir, we have been here more than an hour and we still don’t know what your basic purposes were in the experience,” complained another journalist. “We would stay many more hours if we thought it would be useful.”

As the *New York Times* noted the following day, the news conference “was characterized by heated exchanges between [Quarles] and newsmen who charged they were not getting sufficient details … Mr. Quarles refused to permit the officials and scientists with him to respond to questions without his specific permission in each instance.”[5]

Uncomfortable and trying as it may have been for Quarles and the assembled newsmen, Quarles succeeded in holding the ground for the administration. As Lisa Mundey points out, “Quarles managed to give less information about the test at the two-hour press briefing than Sullivan and Baldwin had presented in their stories.”[6] The *Los Angeles Times* complained, “His answers were so guarded that it was virtually impossible to learn specifically what had been accomplished in the tests.”[7]

One thing that Quarles did reveal, whether inadvertently or on purpose, was his displeasure at the whole affair. “He announced that he was sorry that the project was no longer a secret, noted the *New York Times*.[8] Walter Sullivan observes, “What seems to have distressed him in particular was the fact that the timing of the announcement of so momentous an event was determined by a newspaper and not by the government.”[9] He quoted Quarles: “It isn’t playing the game with the Department of Defense just the way I would like to see it played.” Still, the *Times* pointed out that “Mr. Quarles, however, would not confirm that he was, in effect, accusing the *Times* of a security breach.”[10]

But whether the Pentagon, the White House, and the military liked it or not, Argus was now public knowledge, and that meant it was fair game for the press corps, as James Van Allen found out that day. He was in California on the morning of the Argus revelations, attending a symposium on “The

Realities of Space Exploration" along with the Jet Propulsion Laboratory's William Pickering and several other luminaries. Though he had of course seen the morning papers and knew in advance that the story was going to break, he was perhaps unprepared to face questions on Argus just yet, and declined to comment on specifics. But a reporter from the *Los Angeles Times* hit him: "If a host of neutrons could be released at great altitude, could they split the nuclei of a missile warhead and detonate it?" Fortunately, Van Allen was used to handling impertinent questions from nosy newsmen. He answered carefully, "Yes, if there were enough of them," stressing that he was speaking purely hypothetically. That didn't stop the *Times* from headlining the article "Space Blast Can Stop Missiles, Expert Says."[11]

The next day's edition of the *New York Times* featured more coverage, focusing not only on the Quarles press conference but also implications for the test-ban negotiations and a profile of Frank Shelton, the enigmatic DOD scientist, technical director of the Armed Forces Special Weapons Project "responsible for developing military requirements for atomic weapons and for conducting atomic tests," and scientific director of Argus.

As the story rapidly spread from the *New York Times* to the wire services and various other newspapers, and news outlets strove to find different angles on the fairly limited information that had been so far released, several figures in the Argus story found themselves the objects of unaccustomed, mostly unwanted attention. For men such as Shelton or Admiral Mustin, who were most comfortable working in the shadows of official obscurity, publicity was anathema. Fortunately for them, the most colorful character of Argus—and thus the one most attractive to the press—was the man who started it all, Nicholas Christofilos.

Beginning with the *Times* initial coverage on March 19, which featured a biographical sidebar on Christofilos and a photo captioned "Can argue as well as a Paris taxi driver," the "Crazy Greek" quickly became the vaguely whimsical public face of the Argus project. His unconventional background and personality coupled with his by-his-own-bootstraps life story were just too good to ignore, and nearly every paper featured a prominent sidebar about Christofilos with their Argus coverage. Whether he wanted to be or not, the scientist had become something of a media star.

It probably mattered little to Christofilos personally. Individualist that he was, he had always been rather indifferent to what anyone else thought or had to say about him, and he had other problems. Not long after the Argus story broke, he filed for divorce from his wife Elly in Berkeley, California, citing "extreme cruelty."[12] Unfortunately, his new celebrity made such personal matters fair game for the press.

Married for about five years, they had already been separated for four months, but Elly still claimed it was a surprise. "I never expected him to do this," she told reporters, sobbing and clutching their two-and-a-half-year-old son Nicholas Jr. "I cling to the hope he may not go through with it." An article in the *Washington Post* noted, "She expressed amazement at the grounds her husband selected. It was plain that to her the words 'extreme cruelty' implied more than what they have come to mean in the United States divorce context."[13]

The Argus revelations affected another principal player in a very different way. While Walter Sullivan was delighted with the big exclusive that he and Hanson Baldwin had brought to the *Times*, noting that "particularly within the scientific community and in the press, the disclosure was welcomed," it had caused Baldwin considerable personal anguish. Baldwin's biographer Robert D. Davies noted that Baldwin "agonized" over revealing the Argus secret. His dual identity as a reporter and as a former naval officer and Annapolis graduate made either decision—to publish or to keep quiet—a betrayal of his personal principles. "His dilemma was acute," Davies wrote. It was only when he heard rumblings that the Pentagon was about to go public anyway at the upcoming NAS conference that he decided to publish.

The story made Baldwin and Sullivan heroes both at the *Times* and among their journalist colleagues. *Time* magazine, for example, praised Baldwin and Sullivan for having "played the game at its best—with initiative and responsibility."[14] But Baldwin was not consoled by such accolades. "Baldwin felt a responsibility of the Times to the public, as well as to the country and the freedom of the press," said Davies. "His military contacts thought that Baldwin, as a newspaper writer, had had no right to determine what the public should read on military-political subjects, but he would reply that that was what a free press was all about … the Argus Project was to Baldwin just another example of the 'developing attitude of the government that the public must know only what the government thinks it is good for it to know'"—a sentiment of which Donald Quarles would no doubt have approved.

Baldwin decided he needed to make some amends. "A week following the story's release, he felt obligated to write to his old friend and valuable news source, Admiral Arleigh A. Burke, the chief of naval operations," noted Davies. Baldwin "confessed that he had 'played the game completely and in fact bent over backwards to avoid injury to the country which all of us serve.' He was very upset that the Navy had been blamed for leaking the story … a lie that he wanted to set right with Admiral Burke."[15]

Because of Argus, Davies concluded, Baldwin "was forced to reassess his views on the Washington bureaucracy. The press corps and government officials no longer shared the belief that they were on the same side, as was the case during World War II … with considerable passion, Baldwin told Admiral Burke that the real issue in all this was neither the security of information nor the denial of data to the Soviets; instead, it was the issue of 'controlling information and … issuing when the government wanted to and under the terms it wished.' In his view, Washington's concern to maintain secrecy had exhibited a 'fundamental failure to understand the first principle of good public relations and of democratic government.'"[16]

A few days after Argus broke, reactions from other quarters began to appear, including from the American citizens who, as a reporter had noted at the Pentagon press conference, paid for the whole thing. Referring to reports that Soviet scientists had in fact detected the Argus explosions, a letter to the editor in the *New York Time*s noted, "the Pentagon kept secret from the American people something which was known to the Russian Army. One wonders who is fighting whom and why."[17] Another reader asked, "By what right can any nation or group proceed to envelop our earth in a band of radiation, the harmful effects of which are still open to debate? … What will be the verdict of future generations, if any remain, on the irresponsibility of conducting nuclear tests without more concern for human welfare and moral issues?"[18]

Others weren't as troubled by such grand moral issues. An editorial in the *Washington Star* noted, "Certain data will remain classified, regardless of those who clamor about the public's right to know. Such secrecy seems reasonable and necessary. After all, given an age as dangerous as the one we live in, there is much to be said for holding one's tongue on occasion … why should we publicize in detail what he have learned? Why should we shout about it from the rooftops?" The *Star* went on suggest that perhaps more high-altitude tests should be conducted, both for the sake of scientific and military knowledge. “Why should man debar himself from these probings? Indeed, how can he do so without enchaining his own mind and sinning against his own questing nature?”[19]

It was not only Pentagon officials and American taxpayers who were exercised about Argus secrecy and the question of revealing it to the world. Seeing the Argus story hit the papers on March 19, Senator Clinton P. Anderson, chairman of the Joint Committee on Atomic Energy (JCAE), was quite annoyed that, as administration officials had previously agreed, the JCAE had not been informed of the release in advance. He promptly wrote to General Herbert Loper at the Pentagon, who was the official liaison to Congress on atomic matters, and demanded an explanation. Loper sent a conciliatory answer, detailing the drama that had transpired within the Pentagon before the *Times* story and accepting full responsibility for failing to notify the JCAE. He had been briefly in Walter Reed Hospital on the evening of March 18 and so had missed hearing about the *Times* informing the government it was about to go public.[20]

Anderson wasn’t mollified. He had been pressuring the Pentagon and AEC for more data on fallout, in preparation for public hearings on the issue later in the year, but the administration had been stalling and dragging its heels. Anderson viewed this latest fiasco over Argus as yet another example of deliberate obstructionism. As political payback, he released to the press some of his recent correspondence with the government on the fallout issue, stating, “The process of making public the ARGUS and fallout information is an example of how difficult it is to make available to the public the information it is entitled to have.”[21]

Another prominent member of the Senate, Margaret Chase Smith of Maine, worried about possible fallout from Argus. Apparently reacting to a letter from an aggrieved constituent, Smith wrote to the AEC asking for more information about Argus’s safety. AEC General Manager A. R. Luedecke responded promptly, assuring the Senator that because of the small Argus yields and the great altitude of the detonations, Argus did not “in any way represent a health hazard to human beings at the altitudes of air transport or on the surface of the earth.” As to the secrecy of Argus, Luedecke noted that “all nuclear test detonations by the USSR have always been conducted in secrecy. It is possible that an experiment similar to ‘Argus’ has been conducted by the Russians.”[22] If the Russians did it, then so could we, seemed to be the implication.

Meanwhile, preparations were underway behind the scenes, as Killian’s PSAC and others in government debated over how much more to reveal in an official White House release at the end of March, and at the upcoming NAS conference the following month. At long last, after playing ball with the government and military and dutifully keeping their secrets, the scientists were about to have their day in the sun.

CHAPTER 11

The Light of Science

A DRAFT SCIENTIFIC REPORT WAS SHUTTLED AROUND THE PENTAGON, WHITE House, IGY Committee, and AEC, undergoing revisions and refinements to ensure that no more secrets were revealed than was already the case. The AEC was concerned only with disclosing the yield of the Argus shots, so that material was duly removed. After some further tweaks here and there, White House Press Secretary James Hagerty released the report on March 25, with Herbert York providing the scientific perspective.

For the administration, it was an exercise dedicated to emphasizing the position that Argus had essentially been a massive IGY science experiment with perhaps some military aspects, rather than a military project that happened to involve some science that could be conveniently shielded by the IGY. A memo from Assistant Secretary of Defense Murray Snyder to General Goodpaster offered some helpful suggestions for talking points to accompany the scientific release, complete with possible questions and answers.

For one, on the issue of delaying the release of the story, the memo noted that “despite rumors to the contrary” (apparently an oblique reference to Senator Anderson), the JCAE had been fully informed of the military implications of Argus and had opposed publication for that reason just as much as the Pentagon. Snyder mentioned the *Washington Star* editorial that had gone on about the “reasonable and necessary” need for “holding one’s tongue on occasion” and suggested that reading a few lines from the piece might come in handy. In response to the question “was the publication of this story a breach of security?”, Snyder suggested a response of “it should be obvious that the original disclosure of the plans for the Argus project, weeks before it occurred, was a serious security violation and a reprehensible thing,” adding that efforts were underway to identify the source of the original leak to Baldwin.[1]

The report released by the White House glossed over any military questions to focus solely on science, describing the theories of Christofilos, the observed Argus effects, and how the various IGY resources were used to observe and record them. “The scientific aspects of these experiments … are regarded by many participants as one of the major achievements of the International Geophysical Year,” said the report. Still, “it was clear that the undertaking involved a mixture of scientific and military interest.”[2] The *New York Times* reported that “Despite the intensity of the artificial radiation, Dr. York dismissed the possibility of creating radiation belts with atomic explosions to kill the passengers in any future space vehicles.”[3]

Not everyone in the scientific community agreed with that assessment, however. Victor Weisskopf of MIT, physicist and Manhattan Project veteran, suggested at a meeting of the American Physical Society that Argus had demonstrated that the radiation environment of outer space was threatening enough that future space travelers might have to restrict themselves to the polar regions, where “escape hatches” allowed a sort of “end run” past the radiation into outer space. As reported by the *Montreal Gazette*, “The Project Argus high-altitude nuclear explosions strengthen a view that the first launching stations for spaceships probably will have to be placed in Polar regions.” Also, Weisskopf “did take issue with some of the published reports about things we might be able to do as a result of the Argus test,” specifically the notion that, as some sources had reported, “neutrons from nuclear bombs exploded at high altitudes could be used to ‘trigger’ an A-bomb warhead in an enemy missile prematurely.”[4]

While some scientists questioned a number of the official and unofficial contentions swirling around the whole Argus story, others dismissed the entire enterprise as “a total failure.” Joseph H. Irani, radiation laboratory director at defense contractor Aerojet General, felt so strongly about the matter that he called the *Los Angeles Times*. The paper requested that he send them a letter explaining himself, which he proceeded to do in great detail.

“Today, when the free world is faced with a ruthless enemy who has no gods nor conscience, the United States is toying hopelessly with a wasteful and trivial experiment,” Irani claimed. “Such an undertaking aimed to build up our defenses against incoming missiles can result only in draining our economy, creating false confidence, increasing fallout and eventually losing both cold and hot wars. So far the results from Project Argus show nothing that we did not know before or can not prove on paper or in the laboratory.”

Specifically, Irani took issue with the idea that radiation from an Argus-type shield could ever be strong enough to knock out warheads, or to effectively blackout radio and radar. Despite being hailed “as tremendous by some and as spectacular by others,” Irani argued that to the general non-scientific public, “it is whatever the official and scientist calls it. It may be called a success while in truth it is a failure. On the other hand, the Russians may be concentrating on more tangible and less screwball ideas than we are.” Irani also raised the specter of nuclear fallout from high-altitude tests, tying in his objections to the ongoing test-ban campaign. Although he made clear that he was speaking only for himself and not for Aerojet, Irani proclaimed Argus “a desperate attempt on the part of our so-called eminent scientists to find a solution for anti-missile missiles.”[5]

Some in the scientific community assailed Pentagon secrecy as the cause for overblown and misleading expectations about Argus. “It is not … the delay in publication of the scientific reports which most needs attention. It is instead the mistaken conclusions in news reports that a magic film of radiation may shield us from missile attack,” wrote physicist William Selove, vice chairman of the Federation of American Scientists, to the *New York Times* and several other major newspapers. That assertion, said Selove, “is a delusion … More candor in the statements from official quarters would lead to much less self-deception by the public.” And such self-deception could only lead to disaster: “Unless the people and the governments make a real effort to understand the overwhelming effects of nuclear war and the fact that a real defense against intensive intercontinental ballistic missiles H-bomb attack does not exist and quite possibly never will, we shall probably stumble into devastation.”[6]

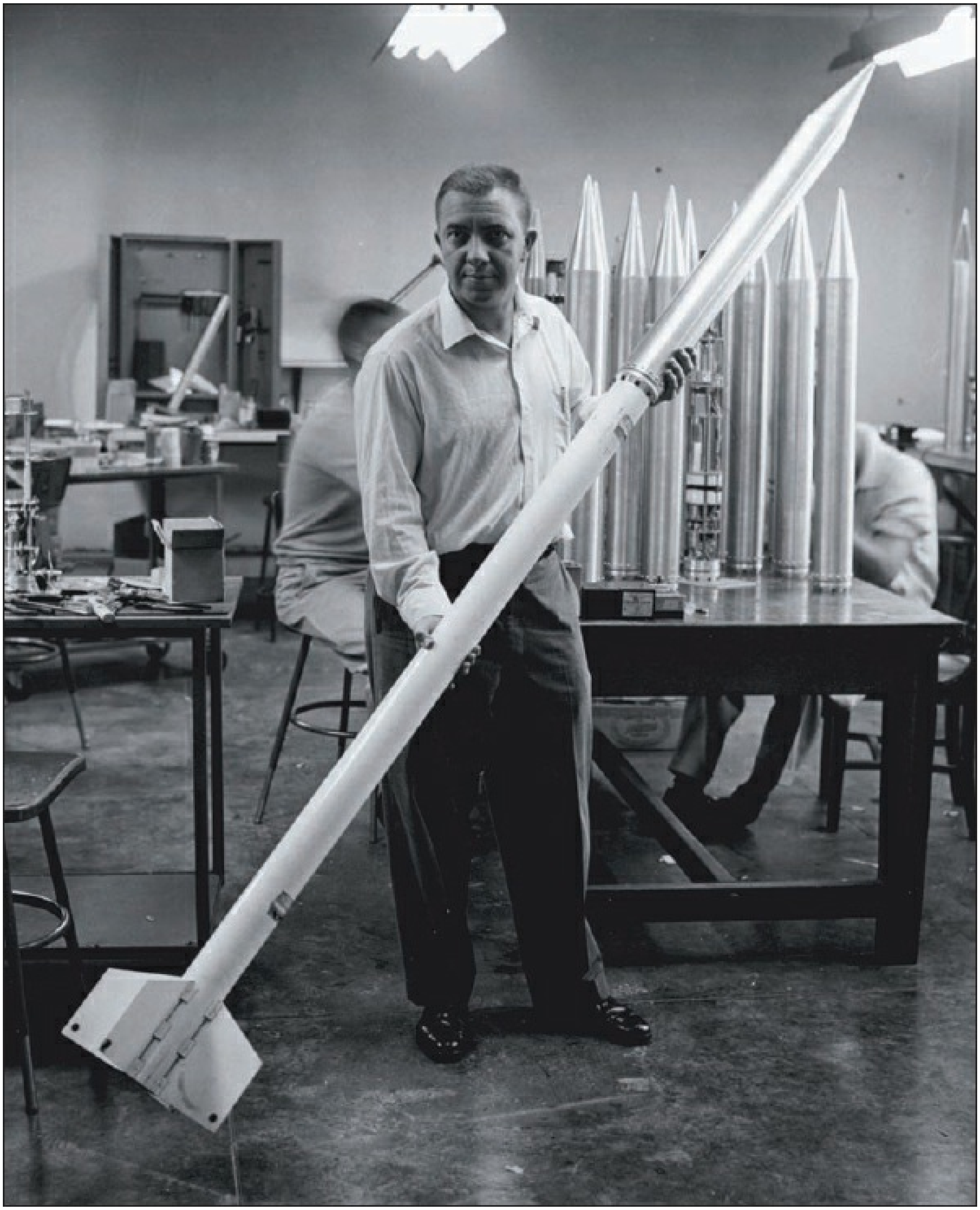
Aside from such voices of dissent, however, the White House release seemed to do its job to almost everyone’s satisfaction. “According to the White House, Argus had always been considered part of the IGY, and the test had not been previously announced so that scientists could follow normal procedures and sort out the militarily relevant information from the scientific,” wrote Mundey. “What had been born a military test had been rechristened an anti-militaristic civilian scientific experiment.”[7]

Still, the largely successful attempt to recast Argus in the innocuous and noble light of scientific inquiry didn’t explain why the Pentagon remained so exercised about its release to the public. Testifying before Congress several weeks later, Snyder was asked whether he considered the Argus story a breach of security. “In my opinion it was a breach of security to print this story unless it was declassified,” he responded, explaining that once the Department of Defense had been informed that the story was about to be published by a certain newspaper, it hurriedly declassified the scientific aspects to limit the damage. “The name of the newspaper was not mentioned,” the *New York Times* noted archly.[8]

President Eisenhower also commented in a statement that “we regret that unknown persons gave out information prematurely and selectively to a single newspaper about the Argus experiments. This unauthorized step removed the decision on release from the orderly processes of Government. It is clear that whoever made this information prematurely available did so without any authorization on the part of the Government. In my judgment it is not in the overall interest of the United States for individuals to decide, on their own, whether and when restricted material should be made available to the press.”[9]

Another reason for the administration’s reluctance to reveal the existence of Argus was the reaction of foreign governments—not merely the obvious and understandable desire to keep the Soviet Union ignorant of the entire affair, but the political difficulties of carrying out such an enterprise without the consent of—or even consultation with—allies and other affected nations. For example, Brazil, in whose general neighborhood the United States had proceeded to detonate nuclear weapons without any sort of notice. Their reaction was less than enthusiastic. The Brazilian press railed about “atomic dust poisoning men in South Brazil” and that “the radioactive cloud produced by three bombs already may be producing effects on men, animals and vegetables.” Brazilian scientists warned of “birth monsters,” though others reassured their citizens that no excess radioactivity had been detected.[10]

Nicholas C. Christofilos, Greek-American physicist, photographed in 1971.
(*Credit: Lawrence Livermore National Laboratory*)

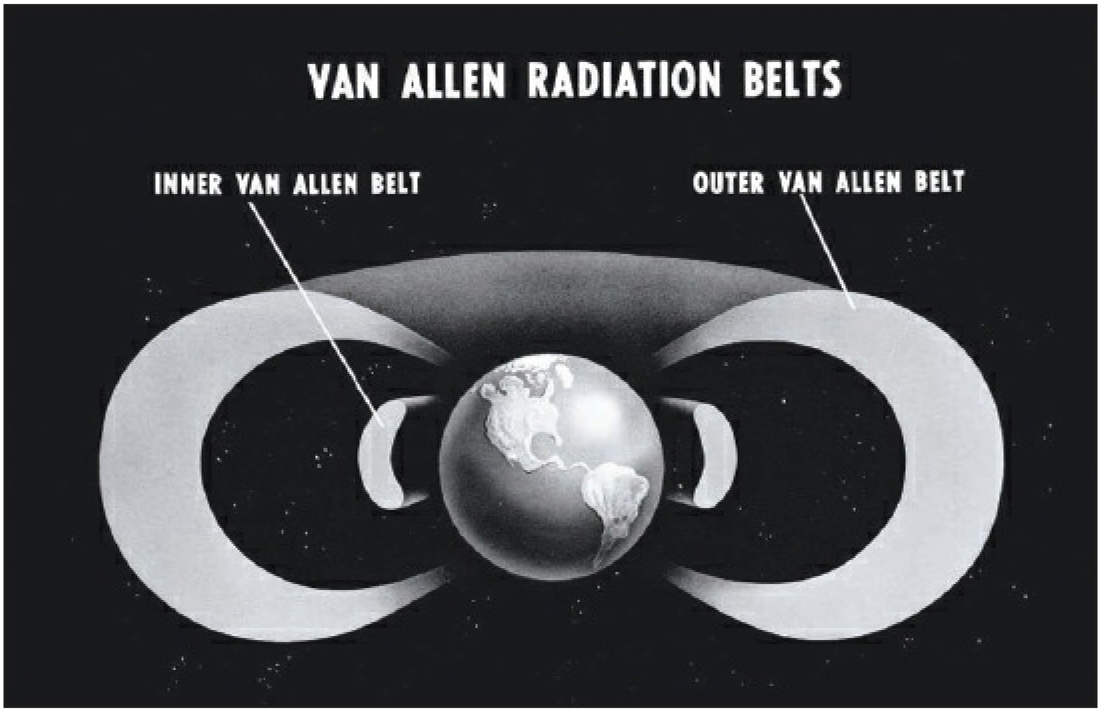


Physicist James Van Allen, here pictured posing in his Iowa laboratory with one of his rockoons.

(*Credit: University of Iowa Libraries*)

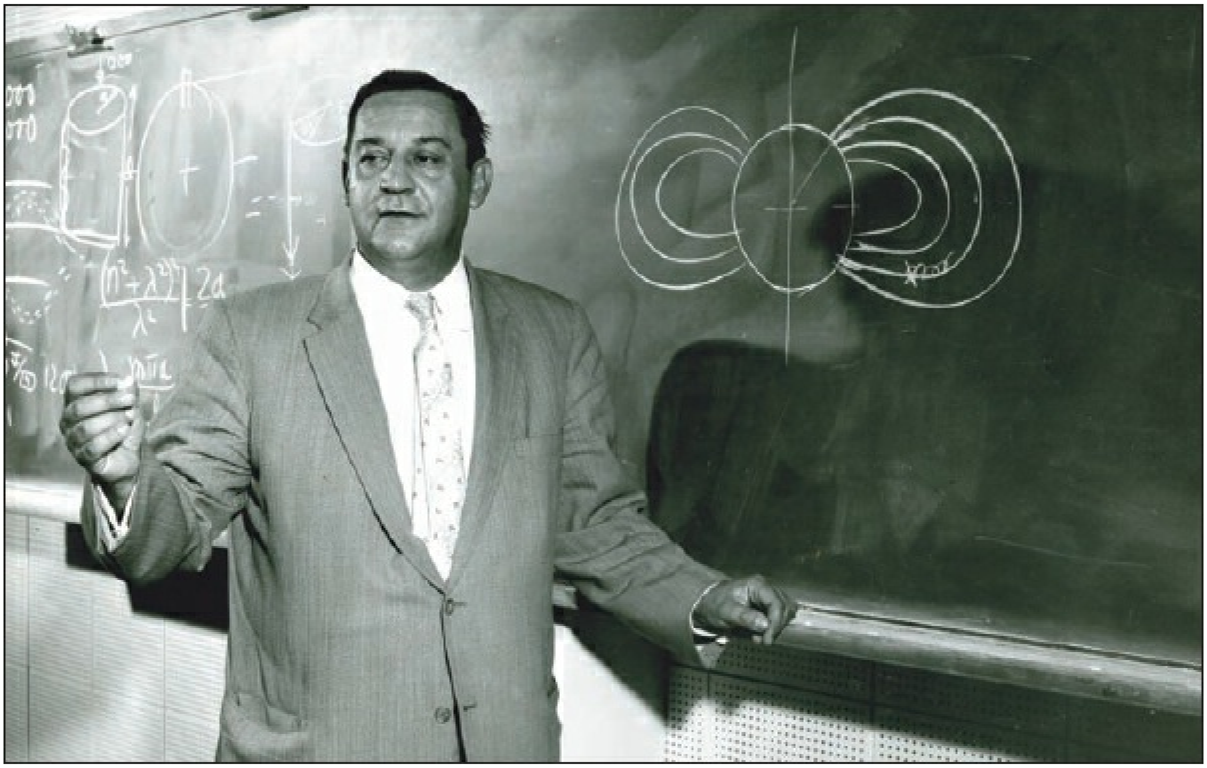
A full-scale model of Explorer 1, America's first satellite, held by its creators. The team was gathered at a press conference at the National Academy of Sciences in Washington, DC, in the early hours of February 1, 1958, to confirm that the satellite, which had launched a few hours before, was in orbit. *From left to right:* Jet Propulsion Laboratory director William Hayward Pickering, James Van Allen, and Wernher von Braun.

(*Credit: NASA / Jet Propulsion Laboratory–Caltech*)



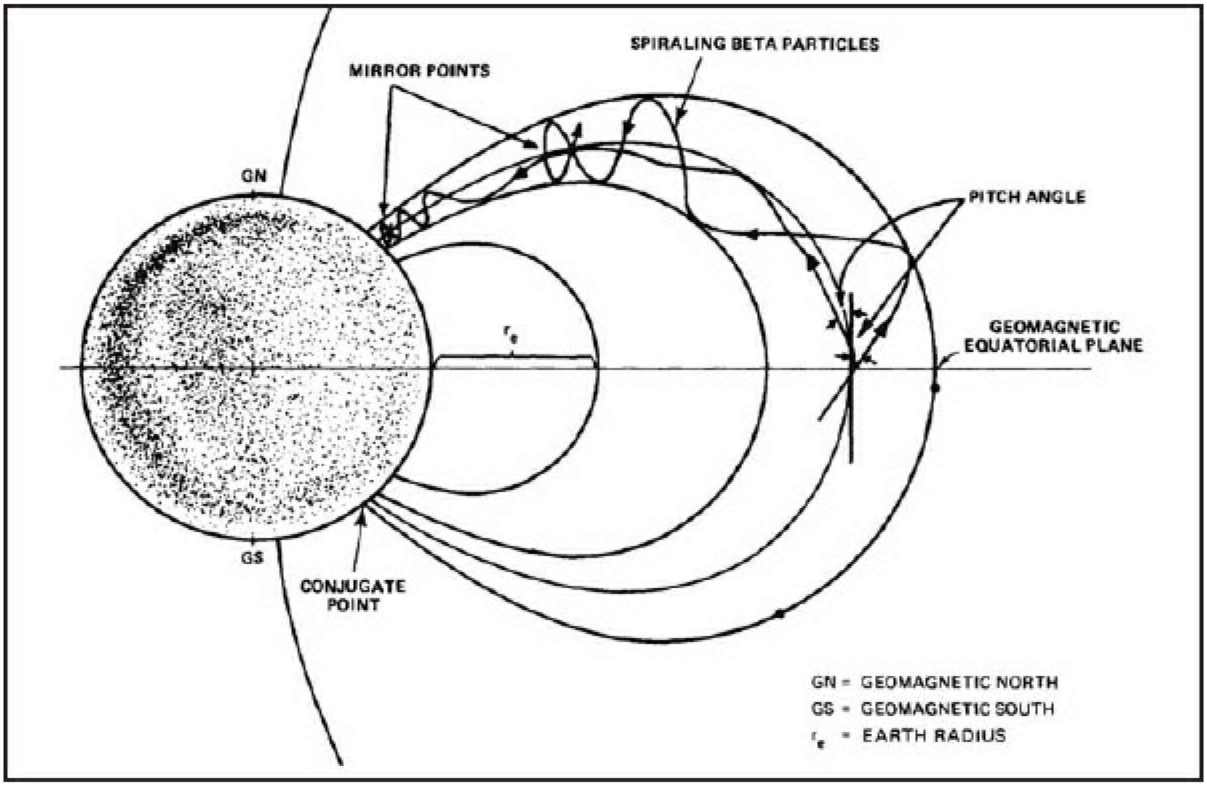
The data from Explorer 1 and Explorer 3 resulted in the discovery that the Earth was encircled with bands of radiation, trapped by the planet's natural magnetic fields; these became known as the "Van Allen radiation belts."

(*Credit: NASA*)



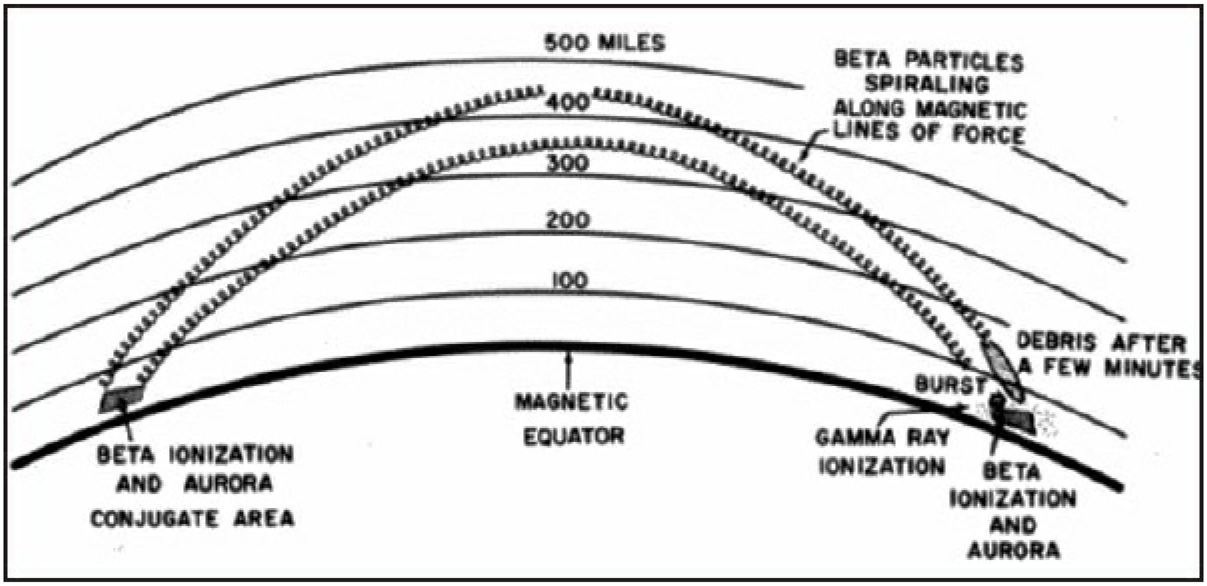
Christofilos explains his latest “crazy idea,” which he coined the Argus effect.

(*Credit: Lawrence Livermore National Laboratory*)



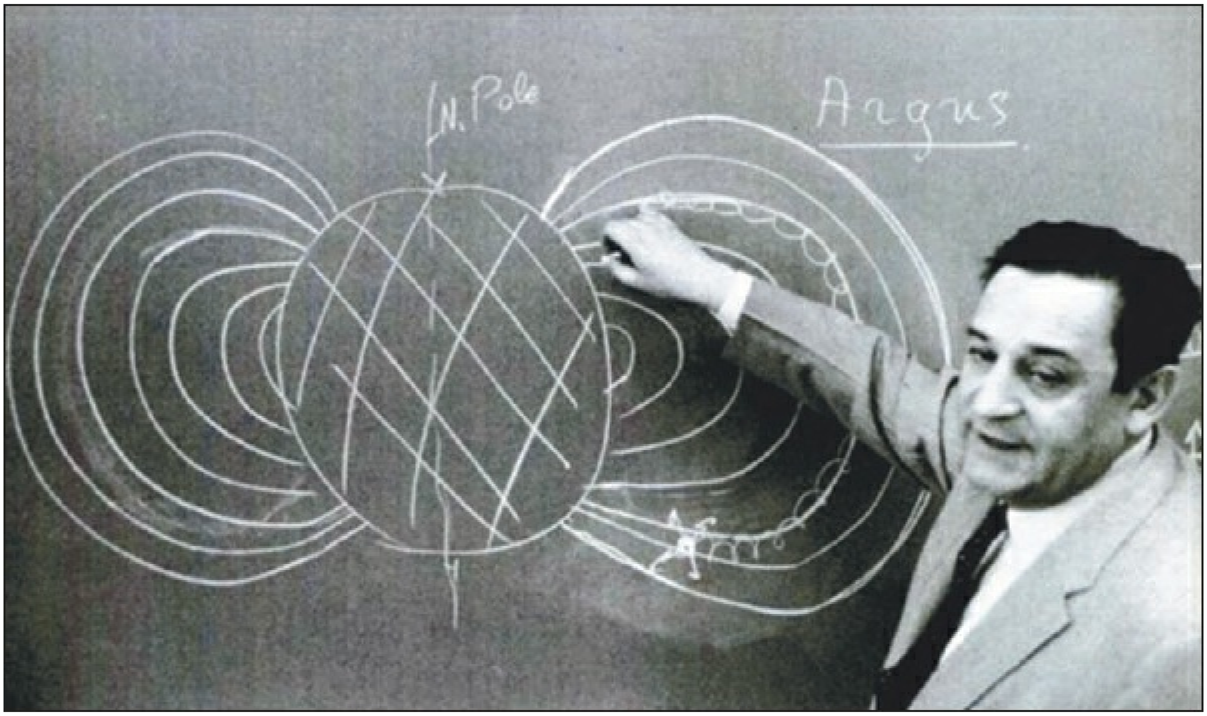
A diagram of the Argus effect.

(*Credit: Defense Nuclear Agency*)


500 MILES
400
300
200
100
BETA PARTICLES SPIRALING ALONG MAGNETIC LINES OF FORCE
DEBRIS AFTER A FEW MINUTES
BURST
MAGNETIC EQUATOR
GAMMA RAY IONIZATION
BETA IONIZATION AND AURORA
BETA IONIZATION AND AURORA CONJUGATE AREA

Another diagram of the Argus effect, illustrating how the high-energy electrons produced by an outer space nuclear detonation travel back and forth along the Earth’s magnetic lines of force.

(*Credit: United States Department of Defense)*

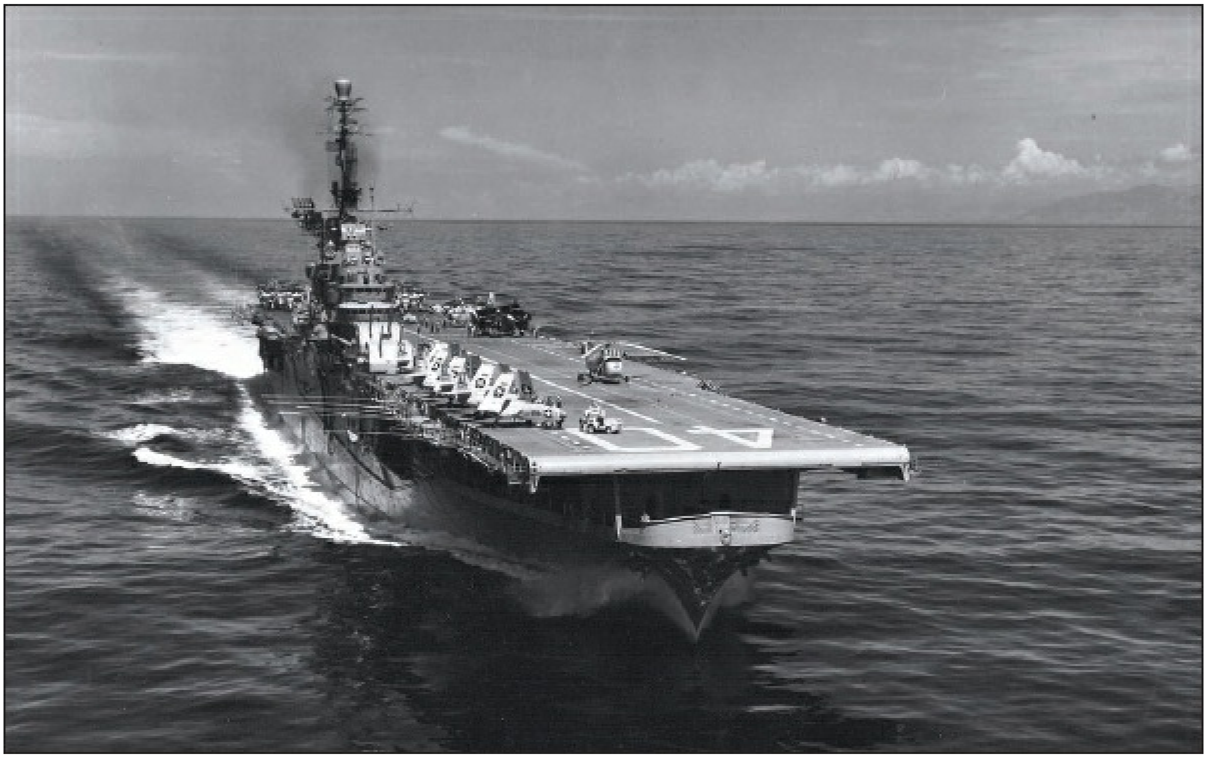


Christofilos explains how a magnetic field encompasses the Earth. He theorized that, if a nuclear bomb was detonated along the planet's magnetic field, some of its radiation would be trapped and would travel along lines of magnetic force to a point at the opposite end of the line (known as the magnetic conjugate area), spreading around the Earth in a thin shell of electrons. Christofilos suggested the possibility that the Argus effect could be used defensively.

(*Credit:* Life Magazine*, 1959, reprinted in* Annals of Iowa, *Volume 70, 4, Fall 2011*)

Rear Admiral Lloyd M. Mustin, reluctant commander of Task Force 88, which was formed by the Pentagon's Armed Forces Special Weapons Project to carry out the highly clandestine Operation Argus.

(*Credit: Mike Green, NavSource Naval History*)



The USS *Tarawa*, the aircraft carrier that served as Task Force 88's command ship and Mustin's headquarters during Argus.

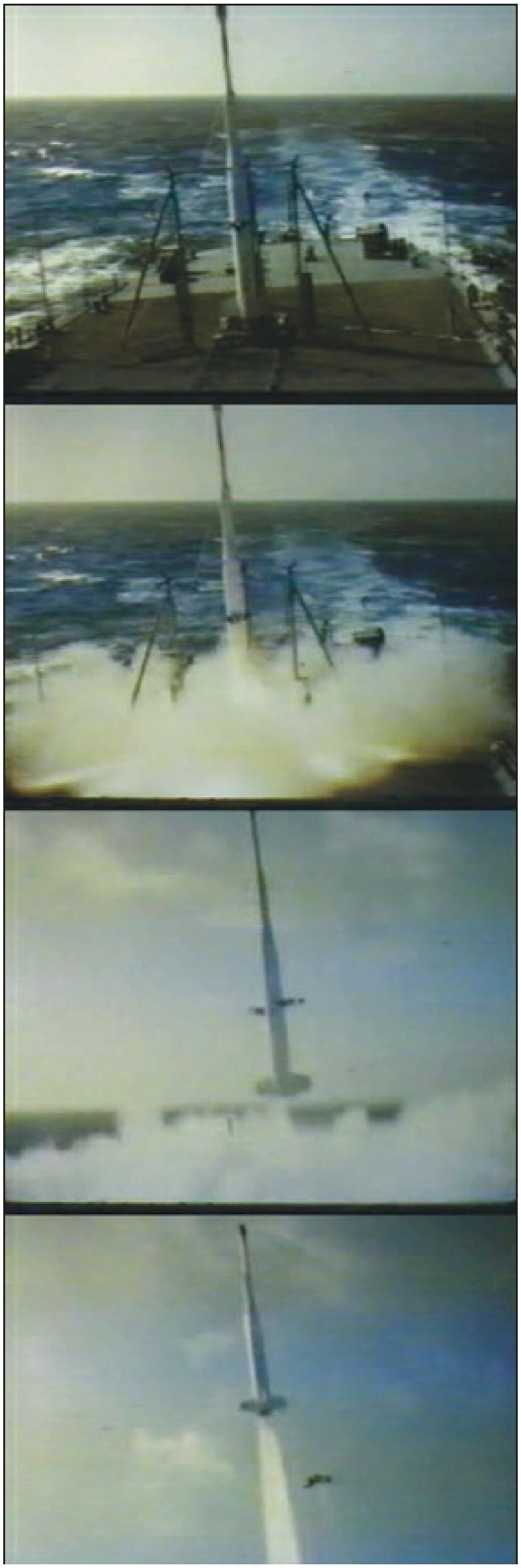
(*Credit: Mike Green, NavSource Naval History*)

The USS *Norton Sound* (AVM-1), the ship that would launch the first nuclear weapons into space. The *Sound* had a vast aft deck that made her a perfect missile-launching platform.

(*Credit: United States Navy*)

Two of the Grumman S2F Tracker aircraft of Tarawa’s VS-32 “Norsemen” squadron that patrolled the Argus operations area for unwanted intruders and also conducted observation flights during the tests.

(*Credit: Allyn Howard, NavSource Naval History*)



A sequence of frames from an X-17a test-firing film on the *Norton Sound*. Note the spin retrorocket package falling away in the final frame.

(*Credit: Department of Defense*)

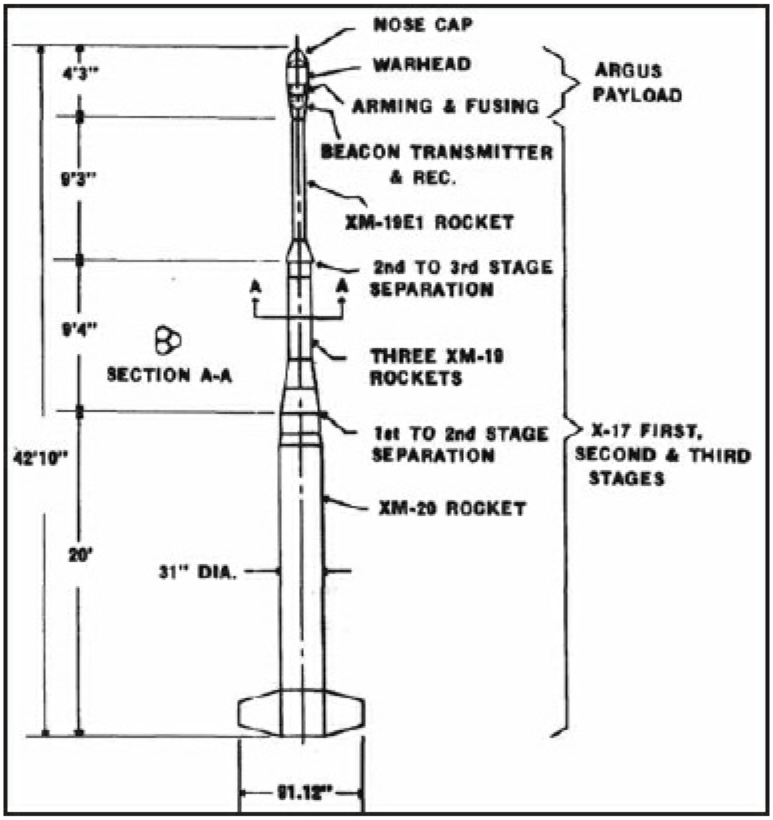
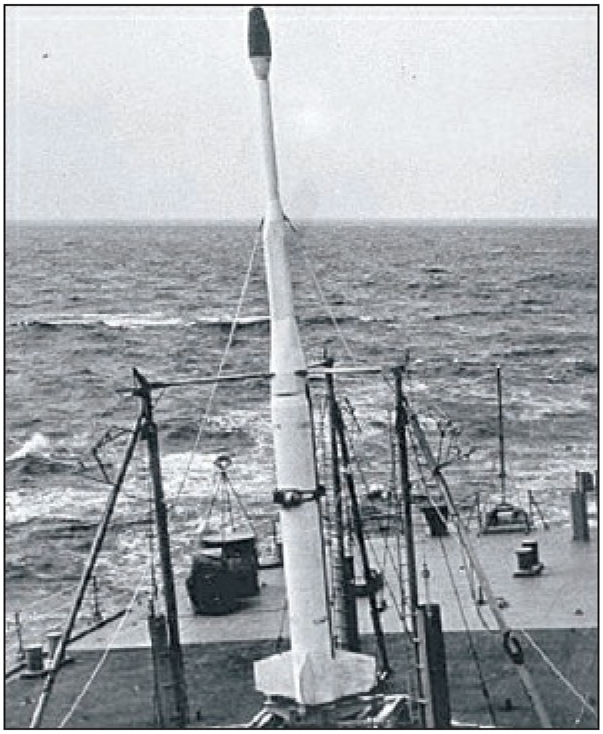


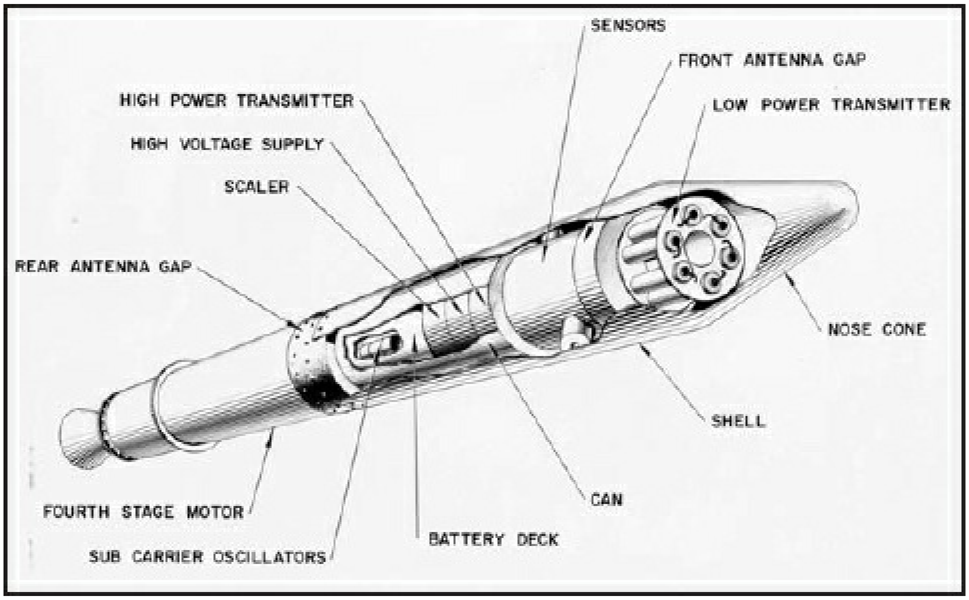
Diagram of the Lockheed X-17a rocket that would loft the Argus warheads into space from the deck of the *Norton Sound*.

(*Credit: Defense Nuclear Agency*)



X-17a missile ready for test firing from the *Norton Sound*.

(*Credit: United States Navy*)

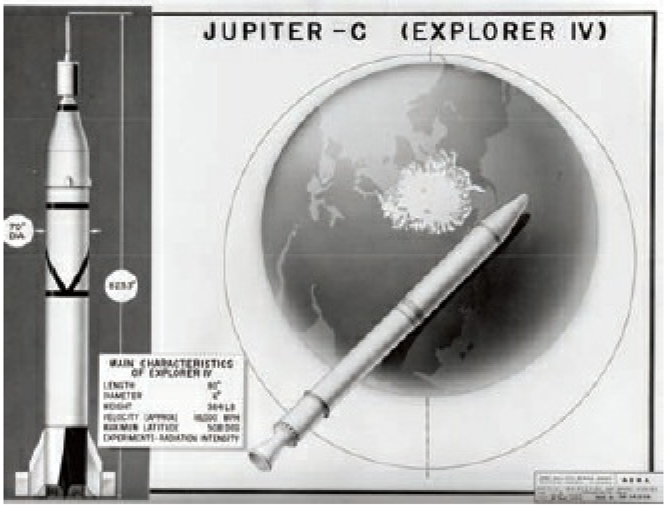


Explorer 4, Van Allen's satellite that would monitor the effects of Operation Argus in space.

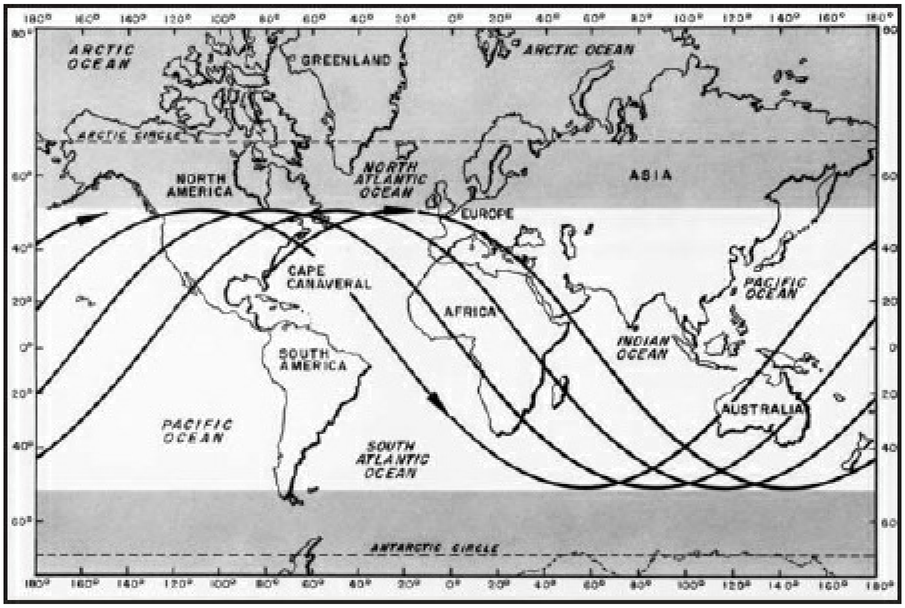
(*Credit: University of Iowa Libraries*)

Before shipping it off to Cape Canaveral, Van Allen plants a farewell kiss on the Explorer 4 instrument package as Carl McIlwain (center) and George Ludwig look on.

(*Credit: University of Iowa Libraries*)

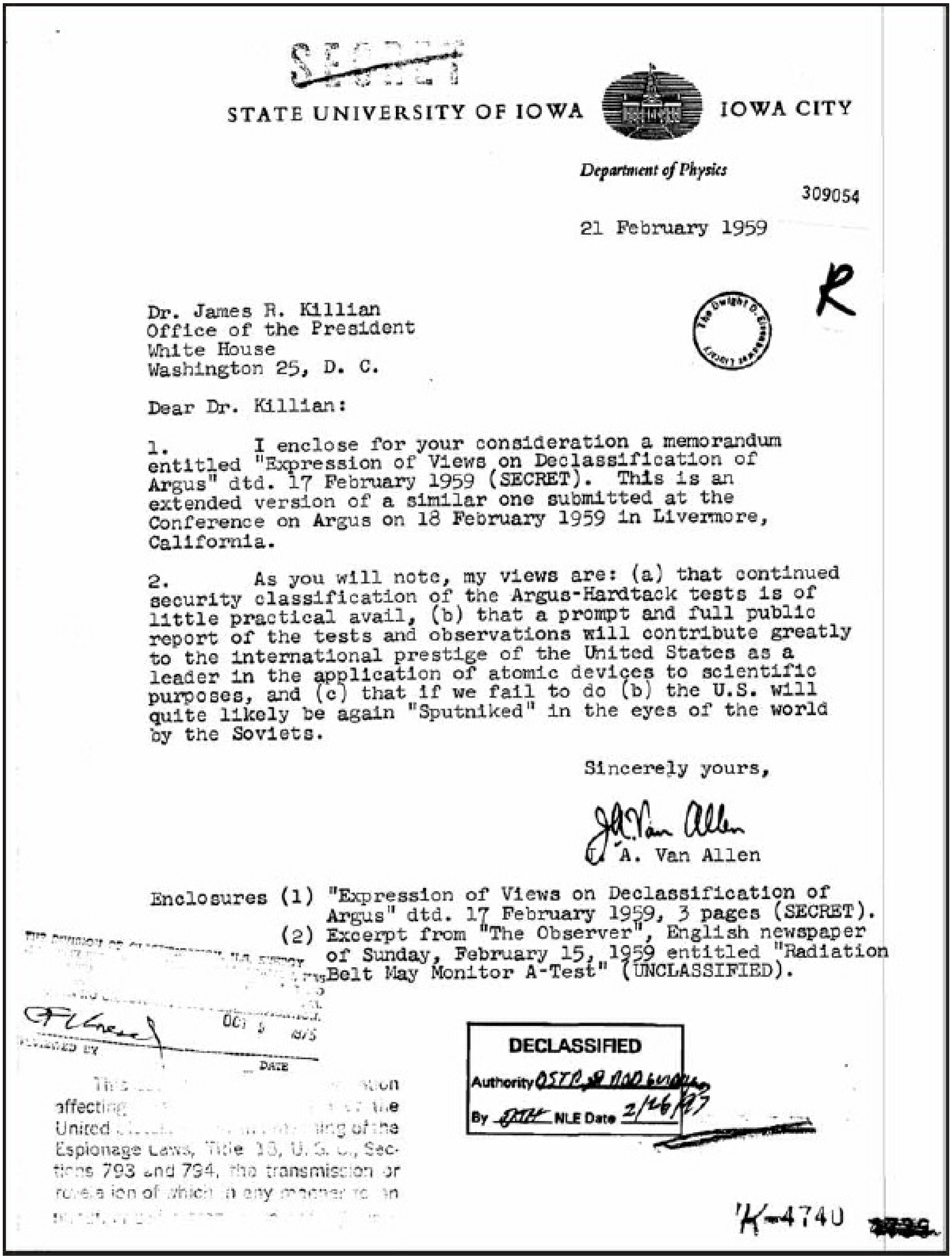

JUPITER -C (EXPLORER IV)
70" DIA.
MAIN CHARACTERISTICS OF EXPLORER IV
LENGTH 80"
DIAMETER 6"
WEIGHT 38.4 LB
VELOCITY (APPROX) 18,000 MPH
MAXIMUM LATITUDE 50 DEG
EXPERIMENTS - RADIATION INTENSITY

The Jupiter-C launch vehicle that would hurl Explorer 4 into orbit.
(*Credit: University of Iowa Libraries*)



The plot of Explorer 4’s first four orbits.

(*Credit: University of Iowa Libraries*)



~~SECRET~~

STATE UNIVERSITY OF IOWA IOWA CITY

Department of Physics

309054

21 February 1959

R

Dr. James R. Killian
Office of the President
White House
Washington 25, D. C.

Dear Dr. Killian:

1. I enclose for your consideration a memorandum entitled "Expression of Views on Declassification of Argus" dtd. 17 February 1959 (SECRET). This is an extended version of a similar one submitted at the Conference on Argus on 18 February 1959 in Livermore, California.

2. As you will note, my views are: (a) that continued security classification of the Argus-Hardtack tests is of little practical avail, (b) that a prompt and full public report of the tests and observations will contribute greatly to the international prestige of the United States as a leader in the application of atomic devices to scientific purposes, and (c) that if we fail to do (b) the U.S. will quite likely be again "Sputniked" in the eyes of the world by the Soviets.

Sincerely yours,

J. A. Van Allen

J. A. Van Allen

Enclosures (1) "Expression of Views on Declassification of Argus" dtd. 17 February 1959, 3 pages (SECRET).
(2) Excerpt from "The Observer", English newspaper of Sunday, February 15, 1959 entitled "Radiation Belt May Monitor A-Test" (UNCLASSIFIED).

OCT 5 1975

DATE

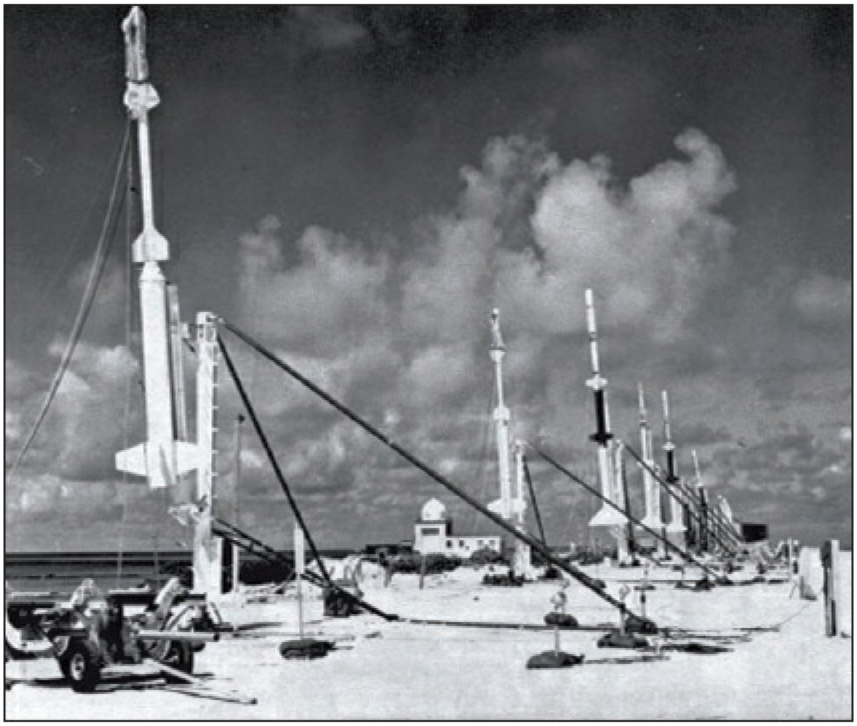
This [illegible] affecting [illegible] United [illegible] of the Espionage Laws, Title 18, U. S. C., Sections 793 and 794, the transmission or [illegible]

DECLASSIFIED
Authority OSTP [illegible]
By [illegible] NLE Date 2/26/97

K-4740

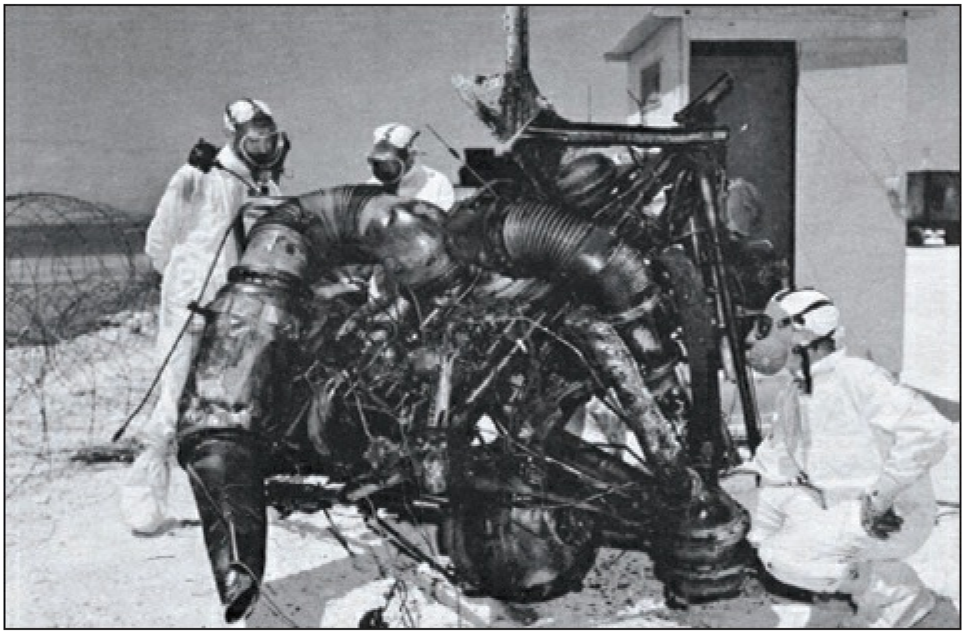
The cover letter of a missive from James Van Allen to James Killian urging for the declassification of Operation Argus.

(*Credit: University of Iowa Libraries*)



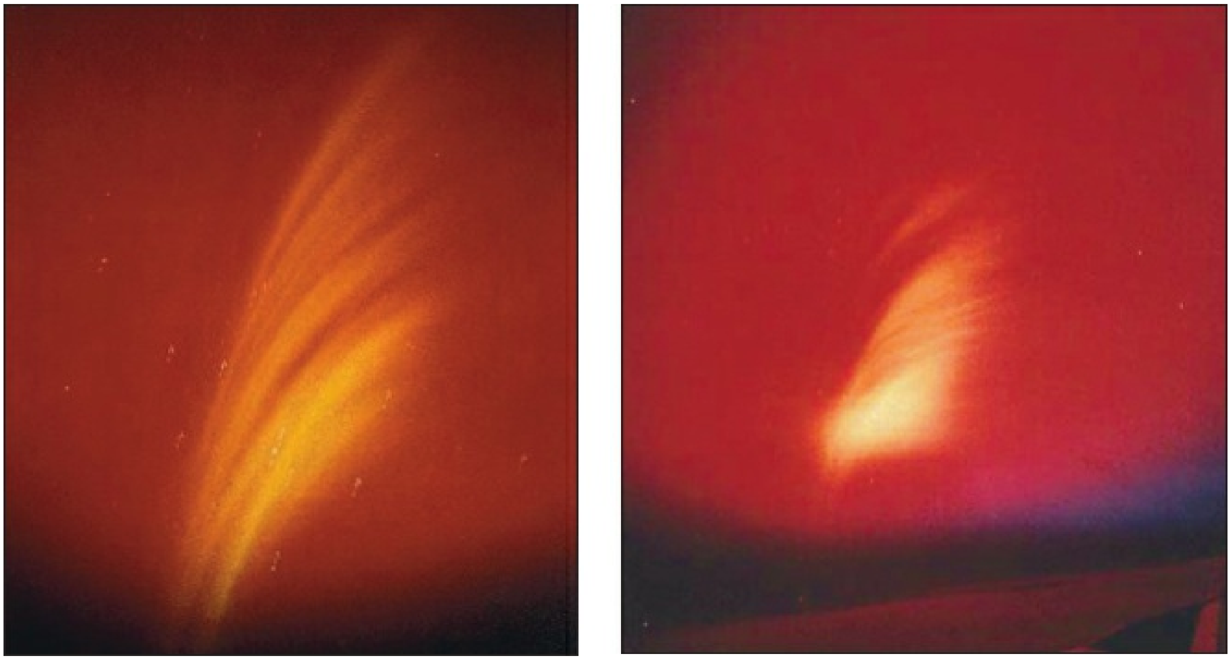
After Operation Argus proved a success, the US once again decided to detonate nuclear weapons in space to test the limits of the now-confirmed Argus effect. Called Operation Fishbowl, the test series was launched from Johnston Island in the Pacific, with various shots at different altitudes and nuclear yields. An array of sounding rockets carrying instrumentation for scientific measurements undergoes liftoff preparations before the Operation Fishbowl high-altitude nuclear tests.

(*Credit: Defense Nuclear Agency*)



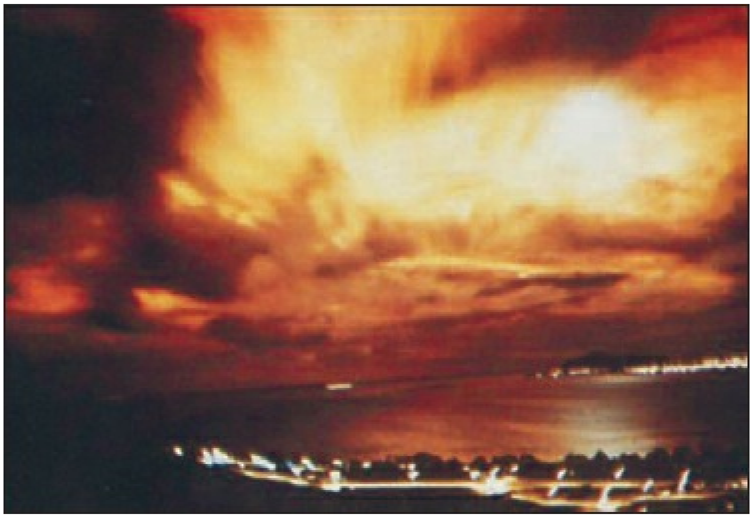
Operation Fishbowl’s Bluegill Prime launch pad explosion would require major cleanup, including decontamination of the irradiated launch site. Workers in radiation suits inspect the remains of the Thor missile engine after Bluegill Prime.

(*Credit: Defense Nuclear Agency*)

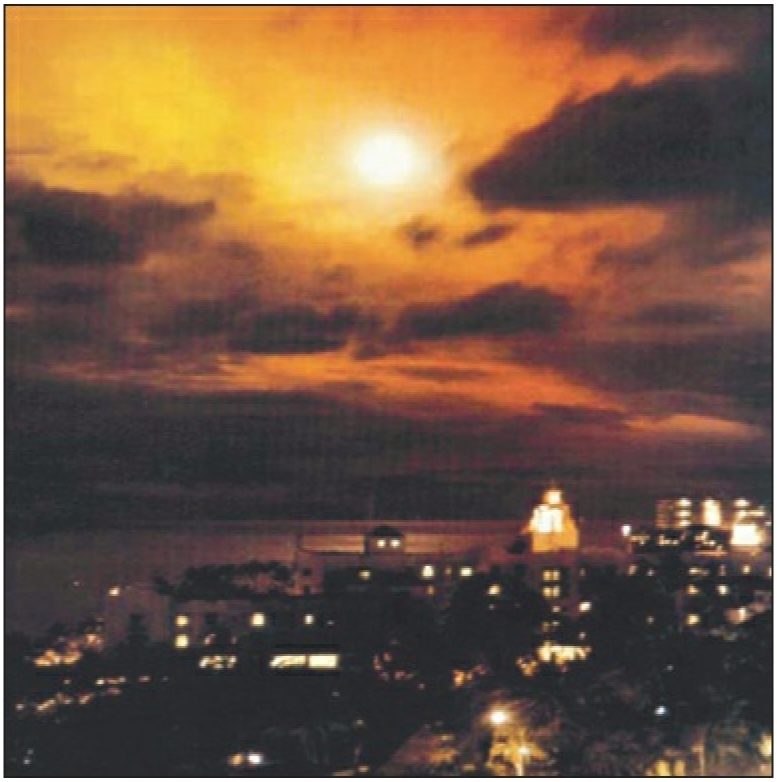


Photos of the effects of the Starfish Prime shot, which produced a light show and boreal effect in the nighttime sky.

(*Credit: Defense Nuclear Agency*)

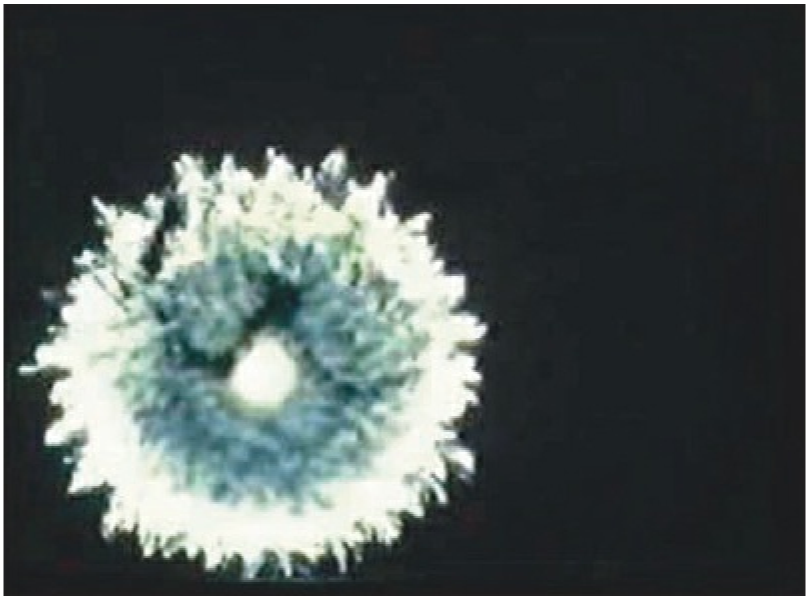


The detonation of Starfish Prime seen through a cloud layer in Honolulu.
(*Credit: Defense Nuclear Agency*)



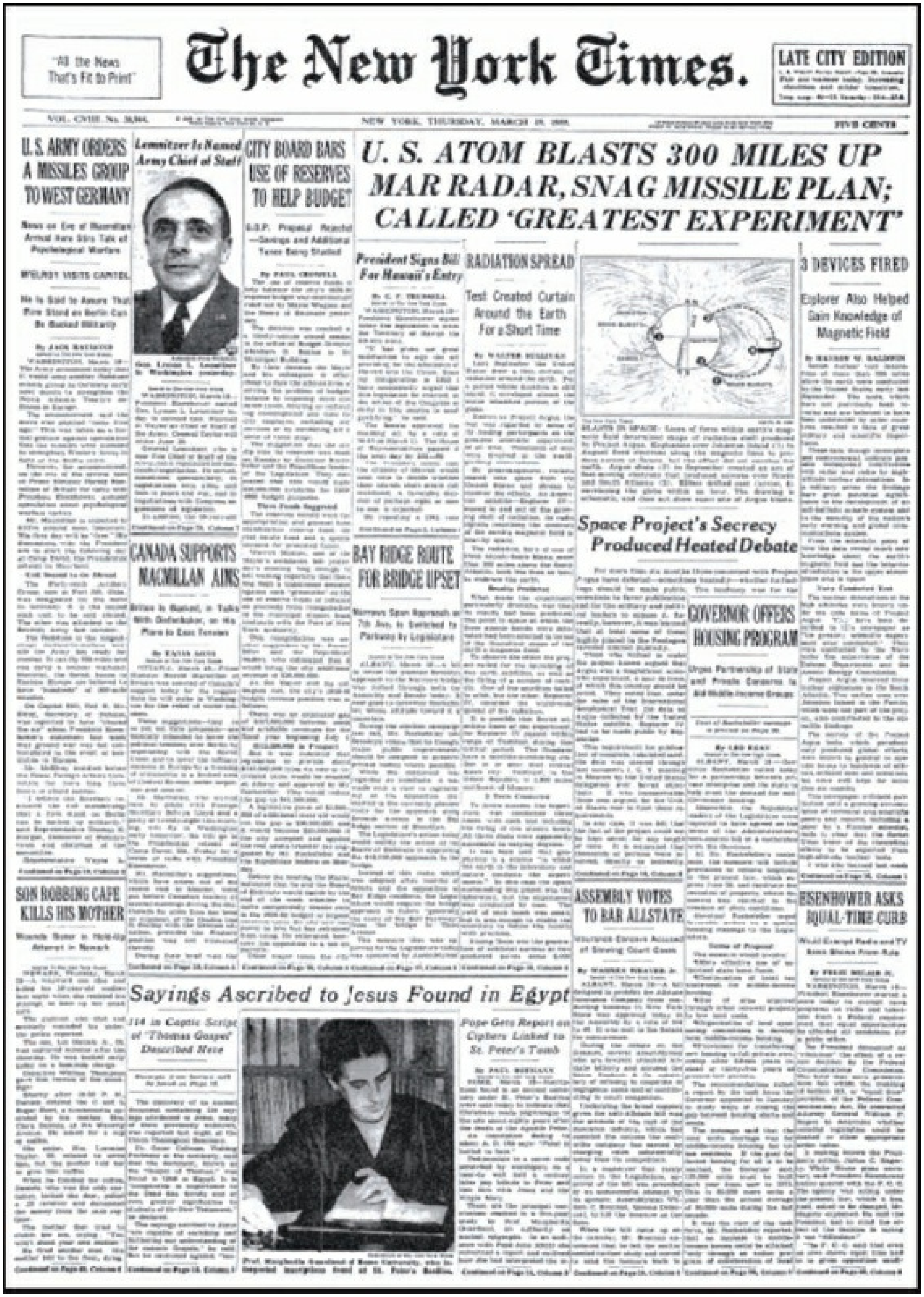
The Starfish Prime fireball from Hawaii.

(*Credit: Defense Nuclear Agency*)



An upper atmospheric photograph of the Starfish Prime explosion.

(*Credit: Defense Nuclear Agency*)



"All the News That's Fit to Print"

The New York Times.

LATE CITY EDITION

NEW YORK, THURSDAY, MARCH 19, 1959

FIVE CENTS

U. S. ATOM BLASTS 300 MILES UP MAR RADAR, SNAG MISSILE PLAN; CALLED 'GREATEST EXPERIMENT'

U.S. ARMY ORDERS A MISSILES GROUP TO WEST GERMANY

Lemnitzer Is Named Army Chief of Staff

CITY BOARD BARS USE OF RESERVES TO HELP BUDGET

President Signs Bill For Hawaii's Entry

RADIATION SPREAD

Test Created Curtain Around the Earth For a Short Time

3 DEVICES FIRED

Explorer Also Helped Gain Knowledge of Magnetic Field

CANADA SUPPORTS MACMILLAN AIMS

BAY RIDGE ROUTE FOR BRIDGE UPSET

Space Project's Secrecy Produced Heated Debate

GOVERNOR OFFERS HOUSING PROGRAM

SON ROBBING CAFE KILLS HIS MOTHER

ASSEMBLY VOTES TO BAR ALLSTATE

EISENHOWER ASKS EQUAL-TIME CURB

Sayings Ascribed to Jesus Found in Egypt

114 in Coptic Script of 'Thomas Gospel' Described Here

Pope Gets Report on Ciphers Linked to St. Peter's Tomb

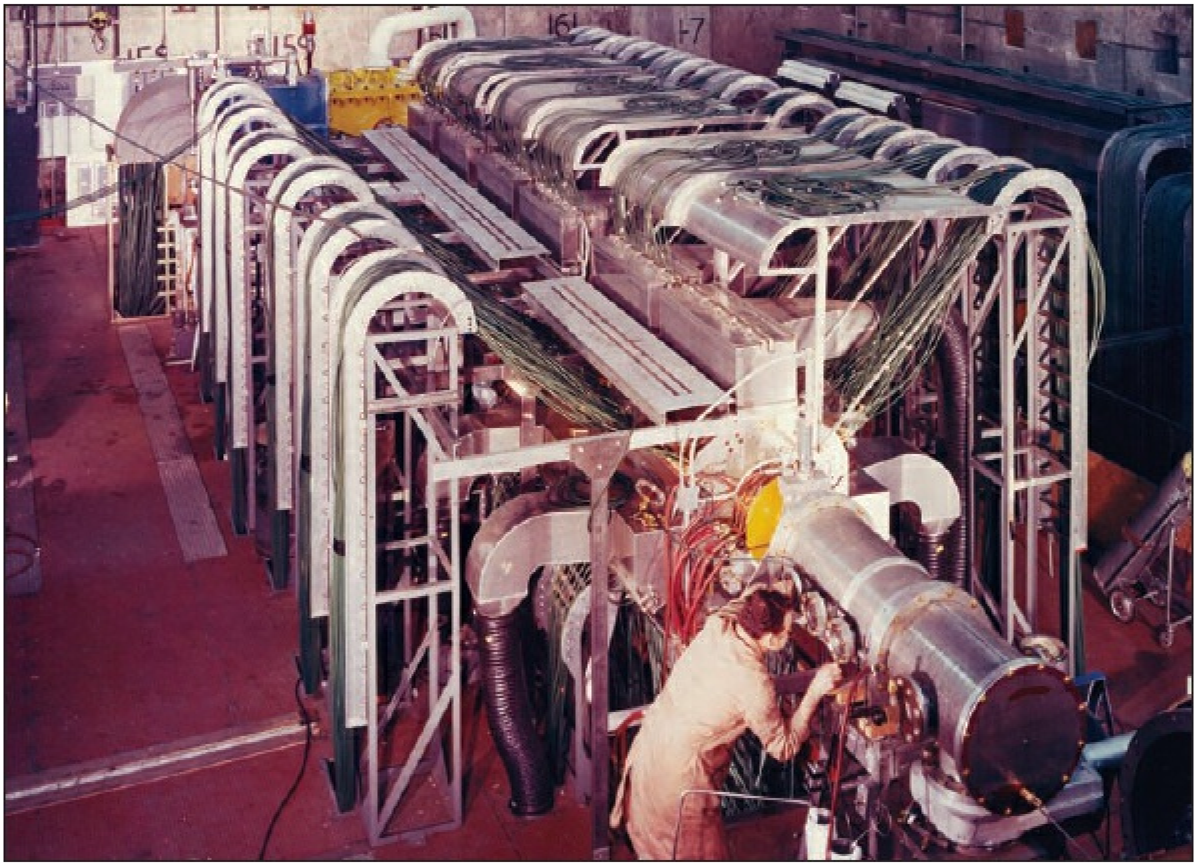
On the morning of March 19, 1959, one of the greatest secrets of the Cold

War became one of its biggest stories when Walter Sullivan and Hanson Baldwin ran their story on Operation Argus in the *New York Times*.

(*Credit: New York Times archive*)

On October 7, 1963, President John F. Kennedy signed the Limited Test Ban Treaty, officially ending the era of nuclear testing in the atmosphere and outer space.

(*Credit: JFK Library*)



The Astron fusion experiment at Lawrence Livermore National Laboratory, the center of Nicholas Christofilos's work after Argus. The photo shows Christofilos's linear electron accelerator.

(*Credit: Lawrence Livermore National Laboratory*)

Christofilos in 1968. He died in 1972, never realizing his grand dreams for Astron.

(*Credit: Lawrence Livermore National Laboratory*)

As the National Academy of Sciences Argus symposium approached at the end of April, efforts continued to figure out what else needed to declassified, both to comply with IGY agreements and to portray Argus as chiefly a scientific experiment. The Pentagon, naturally, continued to play things quite close to the vest, while the scientists, led by Van Allen, pushed for the release of more data, such as shot yields, exact times, and precise latitudes and longitudes.

In a letter to Killian shortly before the symposium, US IGY satellite committee chairman Richard Porter and IGY US executive director Hugh Odishaw set out the scientists' case. "Such data are necessary if the various papers having to do with observed effects are to be scientifically meaningful," wrote Porter and Odishaw. They pointed out that because "a competent scientist" could already figure things out fairly accurately from the already-released data, there was no useful purpose to be served by keeping it classified. And exact data would be far more valuable. "It will not suffice to permit a few US scientists to use these data and then, without disclosing their calculations, state that a particular theory has been verified or not verified." Scientists, Odishaw and Porter were saying, needed to show their work. They argued that such information could easily be disclosed while still keeping secret military details such as the types of warheads and rockets used.

Again, there was also the issue of international prestige and politics. "It is important to give the greatest possible appearance of frankness in order to offset the impression that the United States has not lived up to its responsibilities in an international program," the scientists warned. "Even though the Argus experiment, as such, was not officially a part of the IGY"—as the White House was claiming, went the implication—"their relationship appears now to be inextricable. Both the domestic and foreign press have accused the United States of cynicism in conducting a secret military experiment within the framework of the International Geophysical Year program … if data basic to scientific understanding are withheld, the world will question US conduct in this matter." Greater openness would also "aid in deflecting alarmist interpretations of the experiment, particularly with reference to fallout."[11] After further discussion with York, Killian recommended the release of more—but still incomplete—details.

On April 29, Christofilos, Van Allen, and the rest of the Argus scientists finally presented their (mostly) complete results to the world in a packed house in the Great Hall of the National Academy of Sciences in Washington.

With the imposing (at least to the lay public) title of “Scientific Effects of Artificially Induced Radiations at High Altitudes,” the NAS symposium was intended to cover the full range of Argus scientific results, with all the major players participating and presenting papers on everything from the Explorer 4 satellite observations to the Jason sounding rocket measurements and other ground observations.

In his introductory remarks, symposium chairman Richard Porter also added to the general confusion. “Despite some newspaper stories to the contrary, there was no commitment under the IGY to exchange information with other nations on the Argus experiment,” he stated. “Argus was not an IGY program; it was a Department of Defense effort.” But because “the Department of Defense and the Atomic Energy Commission have now released the information you are about to hear this morning so that it can be made part of the synoptic geophysical record,” he proceeded to disclose reasonably approximate times and locations of the Argus shots.[12] The scientists had won this particular argument, at least to some degree.

Then the presentations began. First up was Nicholas Christofilos himself. He sketched out the background of Argus, including how he had originally conceived of the whole idea and how it had grown out of his Astron fusion reactor research. The Astron reactor, he explained, involved the idea of creating a cylindrical layer or “bottle” of electrons to contain a high-temperature magnetic plasma. Because he became interested in space after the first Sputnik was launched, “it occurred to me to extrapolate this idea of the electron layer to global dimensions.”

No doubt to the relief of both Pentagon officials and scientists in attendance, Christofilos neglected to mention the possible military implications of such an idea, noting instead that “it is obvious that the scientific aspect of such experiments is extremely important.” He recounted the discussions at Livermore, his first classified paper, and the Argus proposal it eventually inspired, confirming that it was Van Allen’s discovery of the Earth’s natural radiation belt that tipped the balance and convinced everyone that Argus had to be done.

After completing a general summary of the project and the observed scientific results, Christofilos argued that they were just beginning: “Continuation of the Argus experiments … may yield new information in addition to that anticipated … there is now available a new tool for exploring the part of outer space encompassed by the geomagnetic field, and for clarifying the phenomena of interaction of the earth’s magnetic field with various charged particles of natural or artificial origin.”[13]

As befitted his lone-wolf reputation, Christofilos presented his paper solo, but the remainder of the presentations were team efforts. Next up was Van Allen, with Carl McIlwain and George Ludwig also credited as authors on the paper titled “Satellite Observations of Electrons Artificially Injected Into the Geomagnetic Field.” Van Allen explained again how “the discovery of the existence of the natural, trapped radiation served as an over-all validation of the Argus proposal.” He proceeded to spell out the Explorer 4 data in great detail, with a great array of charts, graphs, maps, and other visual aids. And he emphasized that the satellite data proved both that the Argus effect was a reality, and that the radiation belt he had discovered the previous year was indeed a natural phenomenon and not somehow created by secret Soviet atomic blasts. He also noted that despite previous estimates, the Argus radiation shell had persisted at least until the previous December. The Pioneer 3 space probe, launched on December 6, 1958, in an unsuccessful attempt to reach the Moon, nevertheless reached an altitude of slightly over 63,000 miles, and before falling back to Earth managed to pick up some faint vestiges of the Argus radiation shell, weak but still active even after three months. Those traces had disappeared by the time the next Pioneer was launched in early March 1959.[14]

Explorer 4 may have been the most visible part of the Argus project before the whole thing became public, but the Jason sounding rocket observations also attracted a lot of interest once they were revealed. The Air Force scientists in charge of that effort—Lew Allen, William Welch, and several other colleagues—detailed their part of the story. The data collected by the Jason rockets “agree qualitatively with those measured by the satellite Explorer IV,” they reported, noting that the rockets also collected some additional information not possible with satellite observations.[15] That was followed by two other members of the Jason team, Jasper Welch and William Whitaker, who offered a heavily mathematical presentation on the theory of trapped electrons. Finally, Philip Newman of the Air Force Cambridge Research Center and Allen Peterson from Stanford gave separate presentations on the various Argus data collected from the ground, including radio, radar, and visual observations.

Over the next several days, the scientists dominated the world news.

Newspapers presented their findings with elaborate diagrams and graphics. Perhaps as a bit of Cold War propaganda boasting of an American triumph, even the United States Information Agency got involved, featuring Argus on their "New Horizons in Science" English language radio program broadcast on the Voice of America on May 7. The show featured recorded excerpts from Porter and Peterson at the NAS symposium, and though it didn't do the same for Christofilos (possibly because of his heavy Greek accent), it reported his declaration that Argus provided "more accurate knowledge of the true shape of the Earth's magnetic field, knowledge that may be of practical importance in radio communications and weather predictions."[16]

Christofilos, however, did speak about Argus on a different Voice of America program broadcast in the Greek language. His proud parents, still in Athens, listened in on one of the still-operating radios their son had built himself during his youthful electronics tinkering days.

The scientific details of Argus were fascinating enough for geophysicists and space scientists, but they also pointed to definite military and political considerations for anyone who cared to approach them from that perspective. Although it had perhaps not been the intention of Van Allen and his colleagues, the wealth of data they had now released also demonstrated quite conclusively not only the possibility of detecting high-altitude nuclear explosions, but more importantly, precisely how to do it—and the vast amounts of data that could be gleaned from such observations. Naturally, anything that American scientists could do, Soviet scientists could do as well, a fact not lost on the Pentagon and White House. These, of course, were much the same arguments that Van Allen and others had used to fight for the declassification and release of Argus data.

At the symposium, the scientists had alluded rather obliquely to such concerns, including the mention of how high-altitude nuclear detonations could interfere with radar and radio communications and Christofilos's observation that, as the internal newsletter of his employer Livermore Lab later reported, "Such experiments must be restricted to small bombs in the kiloton range, because megaton fission released in the proper location in outer space could create a radiation hazard for several days or more for outer-space travelers."[17] Some in the press seized upon this to play up the radiation shield angle. "Expert Says One Bomb Can End Satellite Life Around World," declared a *Washington Post* headline. The accompanying story opened with the alarming lines: “A 1-megaton atomic bomb exploded at the proper point in outer space can girdle the earth with a band of lethal radiation within minutes. A man on a satellite within that band would be dead in less than 3 hours.”[18]

But whether such a phenomenon was ultimately a hazard or a weapon depended upon your point of view—and on the identity of the affected space travelers, spacecraft, or missiles. The Christofilos Effect (or alternatively, the Argus Effect) had been conclusively, if only weakly, demonstrated by the low-yield Argus tests. What would happen with more powerful nuclear explosions? Could the Argus Effect be used as Christofilos had originally intended, to destroy enemy missiles, and if not, to at least cripple them? And if that wasn’t possible, what about using it to disrupt and knock out enemy communications and radar systems?

Such questions were on the minds of congressmen at a closed hearing before the House of Representatives Committee on Science and Astronautics a couple of weeks before the NAS symposium. York and Shelton, as the top Pentagon scientists for Argus, both testified. Committee chairman Overton Brooks and his colleagues managed to learn some intriguing things about Argus that had not been revealed in the news articles, the White House release, and the NAS symposium.

York laid out the general chronology and details, including the reasons for keeping certain information classified. Some of the confusion in the press had actually been working to the government’s advantage. “The newspapers published the altitudes as 300 miles. We have simply let it stand there. All we have said is that the shot burst was well outside the earth’s atmosphere. The reason for keeping this classified is that one of the ideas and—practically everything that was seen in this experiment confirms the ideas of Christofilos.”[19]

As for the locations and times of Argus, “The reason for keeping the precise time secret is that when you explode a bomb anywhere around the earth, there are certain radio signals which are produced,” explained York. “The observation of these radio signals are important in connection with detecting explosions.” So specifying the shot times within about ten minutes before or after “is good enough to be useful in connection with the scientific applications of this data, but it is vague enough so that we think that the Russians can’t work this down to the point where they know what kind of signals this produced.” York also pointed out that because the Argus shots were relatively small, press reports of worldwide effects “are based on a confusion of these shots with the high-altitude shots in the Pacific which did produce large-scale disturbance”—a reference to the Teak and Orange shots that had preceded Argus in 1958.[20]

Because the hearing was conducted in secret, the questions focused more on the military ramifications of Argus than its scientific discoveries. The congressmen seemed particularly intrigued by the effect of high-altitude nukes on communications, especially when York observed: “If instead of being small, if this bomb had been very large, then shooting it in the South Atlantic would probably have interfered with communications across the North Atlantic. So that it gives you the odd opportunity of firing a bomb in a completely remote part of the world which is under your control—or under no one’s control, perhaps—and producing a communications interference at a place which is not available to you. In other words, if we fired this bomb in the Indian Ocean we could have disrupted shortwave communications in the vicinity of Moscow.” Although that “would take a bomb of large yield and not this little bomb,” it was “a rather interesting possible weapons effect … if you do it in the South Pacific, somewhere around the tip of South America, you can interfere with communications in Washington.”[21]

Pennsylvania’s James Fulton, after some queries on Argus science, returned to the military implications, asking York if such an effect might be used “to get through radio, radar, and other communications that Russia or any Iron Curtain country might have set up as a defense … to have our strategic air force pass into Russia without detection?”

“That is one of the things people had in mind here,” York responded. He emphasized that there was still much that remained unknown, making it difficult to seriously discuss specific strategic or tactical military possibilities. Was there even a consensus that there was any point in striving for some kind of missile defense system? “I think there is simply a divergency of opinion here,” said York. “There are people who feel it is worth continuing. There are a few who feel it is worth speeding up. There are a few who feel that there just is not anything along this line at all … that is why we have to keep at it all the time.”

Another congressman wanted to know about fallout from these high-altitude explosions. “We are still working on that question,” said York. “We do not know the answer.” He noted, however, that because fallout from high-altitude explosions takes much longer to return to earth, most of it is probably decayed by the time it reaches the ground.

The politicians were highly exercised by the secrecy issue, especially how a supposedly classified project was uncovered by a newspaper. How was such a serious security breach possible? Was everything being done to locate the source? Shelton assured the Committee that it was. That didn’t placate Frank Osmers of New Jersey, who worried that if the *New York Times* could find out about Argus, then “I presume the Soviet Union knows as much about it.” Congressman Emilio Daddario of Connecticut, not accepting York’s assertion that Hanson Baldwin and Walter Sullivan had just been supremely persistent and dedicated newsmen, even raised the specter of a possible spy ring: “Apparently there is a chain which got the plans into the hands of these people … and any program of whatever importance we put through from this point on, we have to assume it is not only in the hands of the newspaper but in the hands of the enemy as well. If someone has so little regard for the security of the country, then they certainly would not have any less regard for the security of giving it to the agents of a foreign country.”

“In this case the Soviet Union did not seem to have it,” York replied patiently. “If they had it, it would have been to their advantage to release it.” As Shelton had previously testified, had the story broken publicly before the Argus operation, “we probably would not have conducted the experiment.”

“We have paid for a fine piece of research for Russia to use against us,” complained Leonard Wolf of Iowa, worrying about what would happen if the Russians decided to disrupt communications in Washington by detonating a bomb at Tierra del Fuego.

“If you want to interfere with communications in Washington, the best thing to do is put the bomb right here,” York said dryly. He agreed that “you can do it by putting it in Tierra del Fuego,” but observed that “it is of much greater concern if they put it right here, because then they can interfere with communications by killing us all.”

The hearing ended on an appropriately apocalyptic note, as Utah representative David King noted that many of his constituents “seem to be very concerned about these experiments that go off in the areas that carry such lethal potentiality with regard to the human race. They seem to feel we are tampering with great forces, the implications of which we know not. We are going willy-nilly not knowing where it will take us. If we make a mistake we will sterilize half the race. They take a dim view of the whole thing.”

“I know that people do,” York replied. But he reassured the Committee that these high-altitude experiments “just don’t do that … I don’t know how to prove that to somebody who doesn’t want to believe it.” He added that “I suppose it is possible we could stumble on to something. We do consider this as carefully as we can … I guess anything is possible. We are as sure as we can be that it is not possible, that it isn’t dangerous.”[22]

However, it was becoming increasingly obvious that, spurred by the revelations of Argus, the Teak and Orange tests of the previous summer, and the rapidly growing campaign against fallout and nuclear testing that had led to the test moratorium, a great many people both in the US and around the world weren’t quite so confident with official reassurances. In fact, just as others pondered the possibilities for further Argus-type experiments after the test moratorium lifted, the public was worrying more and more about what might happen if atomic and thermonuclear weapons continued to be detonated with such careless abandon all over the world—and how it could be stopped once and for all.

CHAPTER 12

The Sky is Falling

AS THE BIGGEST PUBLIC CELEBRITY OF THE ARGUS SCIENTIFIC CONTINGENT—AND undoubtedly the one most experienced in dealing with the press—James Van Allen was invited to write and speak further on Argus in the coming months. Perhaps the most exotic invitation came not from yet another American university, chamber of commerce, or Sunday newspaper supplement, but from the Soviet Union.

Now that the IGY had officially wound up all its worldwide activities and closed up shop as of December 31, 1958, the multitudes of participating scientists were deep into analyzing, interpreting, and presenting the fruits of the eighteen-month enterprise. That included the Russians, who hosted the Cosmic Ray Conference of the International Union of Pure and Applied Physics in Moscow in July, 1959. As one of the world's foremost authorities on the subject, Van Allen was invited as a matter of course, but especially to discuss his work on the Argus project. Although the NAS conference at the end of April had been completely open to the national and international public, the papers that Van Allen, Christofilos, and the rest of the scientists had presented there were still in press and had yet to appear in the official journal of the NAS, *Proceedings of the National Academy of Sciences*. Van Allen's Russian colleagues, not to mention other international researchers, were eager to hear the details of Explorer 4's probings of the Argus effect from the man himself.

The Russian scientists were sincerely concerned with the scientific aspects of it all, but with the test-ban negotiations between the US and USSR dragging on in Geneva, such information obviously also had political ramifications. Those may have been exacerbated by the June 1959 release of a joint report from the Atomic Energy Commission and the Defense Department on the effects of 1958's high-altitude Teak and Orange shots, which revealed how the tests had disrupted and partially blacked out radio and radar for thousands of miles over the Pacific, from Australia to Hawaii—

and also noted how rabbits, used as test subjects, were blinded even at great distances by the intense flash of the explosions.

Coming close on the heels of the Argus revelations of secret high-altitude nuclear testing, these new reports added to the already fair amount of consternation in the press. “High A-Blasts 300 Mi. Away Damage Eyes,” headlined the *Chicago Tribune*. “Radio Was Snarled By H-Bomb Blasts in ’58,” said the *New York Times*, also noting that by “‘sheer coincidence,’ according to officials, the report was released on the same day on which the nuclear powers agreed at Geneva to hold further technical discussions on the problems of detecting atomic explosions at high altitudes … the report also clearly indicates that hydrogen bombs exploded in the stratosphere could prove to be a valuable method for disrupting radio communications and radar warning systems in advance of an enemy missile attack or bomber raid.”[1] These stories merely served to emphasize a Bureau of Standards report released about a month earlier that, as the *Washington Post* reported, “the blasts disrupted for hours radio circuits between Sydney, Australia, Wellington, New Zealand, Honolulu, Vancouver, and San Francisco. Some circuits … were out for days.”[2] The news reports did distinguish between the Argus shots and the Pacific tests, explaining that unlike the relatively small Argus blasts, the latter tests were hydrogen bombs exploded at much lower altitudes.

As if all this wasn’t alarming enough, York and Shelton’s congressional testimony in April had also been released in heavily censored form. The papers jumped on York’s musings that a high-altitude nuke over the Indian Ocean could black out Moscow, or one over South America could do the same to Washington.[3] That was alarming not merely on a visceral level but on a political one. As the Federation of American Scientists noted in their newsletter, “[T]hat we have in fact been testing nuclear weapons in space makes it clear that some sort of arrangement with regard to such explosions will have to be discussed at Geneva.”[4]

So as the summer of 1959 settled in over the world—along with the radioactive fallout from the extensive US and Soviet testing of the previous year—high-altitude atomic bombs were on everyone’s mind. Military officials worried about the threat they posed (while also keen to exploit their strategic and tactical potential); negotiators in Geneva worried about the political complications they created for a test ban; civilian activists and the general public worried about fallout and helpless blinded rabbits; and scientists enthused over the geophysical secrets they were revealing about the outer space environment.

It was in this unsettled climate that Van Allen journeyed to Moscow in June, along with some of his American physicist colleagues, on a $1,200 travel grant from the National Science Foundation. But not before he received a visit from an enigmatic government official, who had a special favor to ask of him.

"The federal agent asked him for a 'trip report' covering questions in eleven areas of interest, including a full description of recent cosmic ray developments, names of institutions and leading scientists, leads on anyone who was secretive or evasive, and all the materials from the conference," wrote Van Allen biographer Abigail Foerstner. In short, Van Allen was asked to "evaluate the status of cosmic ray research in the Sino-Soviet bloc," and given a list of ten locations of interest he might visit.[5]

Ever dutiful, Van Allen agreed, and departed for Moscow. While in the USSR, he assumed as a matter of course that, as a prominent American and particularly one involved in research related to military issues, he was under discreet KGB observation, and his Russian counterparts had probably been given similar instructions to feel out their American colleagues for any interesting tidbits of information. But he proceeded to present his Explorer 4 observations and Argus results just as he had already done at the National Academies symposium, to the fascination of the Russian researchers. Van Allen toured Russian labs and research facilities; he met his Soviet counterpart, Sergei Vernov, who had designed the scientific instruments for Sputniks 2 and 3. As was usually the case among professional scientists, it was all friendly and collegial, even if the activities were being constantly shadowed by incognito KGB officers.

Van Allen later admitted to a twinge of concern when colleague Leonid Sedov invited him to a seminar at the USSR Academy of Sciences to talk further about Argus. It hadn't been part of the previously scheduled itinerary, and as George Ludwig noted, "Everyone was edgy during those Cold War years … it was not unknown in those days for visitors to the USSR to disappear."[6]

But the invitation seemed legitimate, and after all, Van Allen was there to talk science to his Russian opposite numbers. As a bit of insurance, he asked two fellow Americans and conference delegates, physicist John A. Simpson of the University of Chicago and MIT's George W. Clark, to join him at the Academy. "I figured that if all three of us disappeared, someone would certainly investigate," he explained later.[7]

His talk at the Academy turned out to be enlightening not only for the Russians but for the Americans. Van Allen learned that both nations had originally suspected that the Van Allen belts weren't a natural phenomenon but a result of secret nuclear testing by the other side. But now that particular suspicion had been defused. "They could see for themselves … how different the Argus belts were from the natural belts. That pretty much laid the question to rest."[8] It was a telling example of the value of international scientific cooperation and the sharing of data.

Van Allen's Russian odyssey had gone over so well, in fact, that it led to a visit in November by Soviet researchers to Van Allen's lab in Iowa. The atmosphere of tension between the two nuclear superpowers may have been continuing as steadily as ever, but scientific cosmopolitanism was at least helping to mitigate its worst aspects here and there.

Meanwhile, back in the States, the debates over government secrecy that Argus had helped fuel were raging, now dealing less with Argus than with the fallout controversy, which by this time had grown into a major worldwide political issue. Senator Clinton Anderson, in a political pique at being kept out of the loop on the Argus *New York Times* leak, had released secret correspondence between the AEC and the Joint Committee on Atomic Energy. They had brought some extremely disturbing facts to light, and Anderson wasted no time in making them the center of the JCAE fallout hearings he was then chairing.

The letters between the JCAE and several Pentagon and AEC officials, including Herbert Loper, Willard Libby, and A. R. Luedecke, confirmed that despite previous public reassurances that the dangers of fallout from atmospheric testing were minimal, high amounts of dangerous radioactive particles had been falling to earth and entering the food chain far faster and at greater intensities than formerly believed. "It looks like strontium-90 isn't staying up there as long as the AEC told us it would," Anderson observed. Even worse, "the fallout is greatest on the United States."[9] While there was no real intimation of intentional deception on the AEC's part, the correspondence made clear that there was far less confidence on the issue among the Commission’s scientists than had been known to the public.

Still steaming about the Argus matter two months later, Anderson published a lengthy editorial in the *New York Times* in early May just as the hearings were about to begin, decrying the administration’s fetish for secrecy and classified data in general, as well as its conduct regarding Argus and strontium-90. “Where should secrecy end and freedom of information begin?” he asked. “Does it make sense for defense information to be labeled ‘top secret’ and yet released in full to the newspapers? Why are questions about the nation’s atomic energy programs met again and again with the reply: ‘It’s classified’? Is the secrecy surrounding the atom justified? Or is the secret stamp perhaps being used as a convenient shield behind which to hide information which someone somewhere happens not to like or to agree with?” Anderson made it clear that he believed that far too often the latter was the case, much to the detriment of the public good. Beyond the public’s right to know, said Anderson, “suppression of information prevents discussion which might produce solutions to the problems at hand. It is impossible to say how many valuable scientific breakthroughs have perhaps been delayed—or even prevented—because scientists were not free to exchange information; how many Christofiloses have gone undiscovered because of secrecy … I am hopeful that our fallout hearings this week may provide some answers.”[10]

The JCAE hearings did not provide any final answers to the dilemma of openness versus secrecy, or a completely satisfactory solution to the problem of radioactive fallout. But they did serve as yet another reminder to all the world’s nuclear powers that fallout was an issue that could not be ignored, disregarded, or covered up. It had first come to general public awareness with the US Castle Bravo test way back in 1954, and went on to become one of the major issues of the 1956 presidential election and a political hot potato ever since.

But now, Ike didn’t have to worry about politics. “Eisenhower, late in his second term, was determined to burgeon his legacy as a peacemaker,” notes the Defense Nuclear Agency history. “For the President, the moratorium on nuclear testing was the harbinger of a relaxation of tensions that would hopefully lead to a nuclear test ban treaty, nuclear disarmament, and overall detente with Moscow.”[11]

Such noble aspirations were all very commendable and played well with the multitudes of ordinary citizens worried about strontium-90 isotopes showing up in milk and the bones of their children, but the testing moratorium, to say nothing of the prospect of a complete or even partial end to nuclear weapons testing, had raised considerable alarm in other quarters. Not only were Pentagon planners and military brass worried about Soviet cheating and national security, but the weapons labs such as Los Alamos and Livermore and the vast infrastructure that had been constructed to conduct and maintain America’s nuclear testing capabilities was now being directly endangered. Even the AEC admitted privately that public opposition had become so passionate that the US would soon be forced to give up atmospheric testing entirely.

But there were practical concerns as well, with the US testing establishment essentially in mothballs since the previous Halloween. Noted an official AEC history, “As summer 1959 dragged on with no perceptible progress in the Geneva talks, pressures began to build within the Administration for resumed testing. During the moratorium the Commission’s laboratories had accumulated various requirements for tests. They also needed to develop warheads for new types of missiles, to proof-test new weapons entering the stockpile, and to gather more information on weapons effects.”

It wasn’t merely a case of institutional ennui. “In the meantime, both the Department of Defense and the Commission had to live with the fact that the voluntary moratorium was denying them the full potential of the nuclear stockpile. Just as worrisome to both agencies was the possibility that by the end of the year the President might once again extend the voluntary moratorium.”[12] If the nuclear weapons establishment remained idle for too long, there were fears that the best scientists and technicians would be forced to leave the weapons labs and military for private industry and academia, a “brain drain” that could seriously cripple US military capabilities.

There was also the problem of getting back up and running if the moratorium did end and testing operations resumed. The military had to decide what units to keep operational and which to deactivate; what facilities at Nevada and in the Pacific to close down and which to keep open; and in general, how to maintain everything on a sort of reduced alert status without losing proficiency or allowing morale to evaporate. One major decision was the disbanding of the military’s Joint Task Force Seven, the massive organization which had been conducting the Pacific test operations. Los

Alamos scientist and historian William Ogle called this “possibly the most serious single move made during the moratorium toward winding down our capability to test in the atmosphere.”[13]

Alternatives to atmospheric testing meant either underground—or, once again, in outer space. The latter possibility sparked renewed discussions over the more ambitious sequel to Argus, called Willow-Argus or simply Project Willow.

That idea had been briefly discussed around the time of the Argus operation but abruptly abandoned when the impending testing moratorium made it a moot point. Now seemed a good time to dust off the concept, but there were still considerable difficulties. “Even underground and high-altitude testing was not free from political complications,” noted the DNA history. “The public controversy over ARGUS six months after the fact had less to do with testing *per se* than with the nuclear agencies’ failure to keep Congress informed of their plans. The implication, disquieting in light of the ongoing test ban negotiations, was that tests conducted in outer space could go entirely undetected. Nevertheless, it was the fallout question that absorbed public attention immediately after the ARGUS revelations. To what extent was high-altitude testing safer than atmospheric tests? How high was high enough to prevent radioactivity from returning to earth? Congressional hearings in May of 1959 produced warnings from AEC, DASA [Defense Atomic Support Agency, formerly AFSWP], and public health experts that even a shot thirty miles up offered only a 50 percent margin of protection. However, at much higher altitudes—ARGUS had taken place approximately 300 miles above the earth—fallout dropped off automatically. For DASA planners, this turned deep space into the next frontier for nuclear testing once the moratorium was lifted.”[14]

So perhaps Argus had paved the way for the eventual salvation of nuclear testing by opening the door to outer space. Whereas Argus had been an initial probing, a proof of concept for the Christofilos effect and its potential, Willow would be far more extensive, involving higher altitudes and far more powerful weapons, building upon the lessons learned and the phenomena observed during Argus and the Teak and Orange shots in the Pacific. It would include far more comprehensive tests of the effects of high-altitude nuclear explosions on radio and radar communications, and soon Pentagon planners envisioned even more: “After the spring 1959 hearings, discussions began between DASA and the AEC to expand the scope of Willow to include AEC requirements for high-altitude testing, detection, and evasion."[15] Although the Argus results had seemed to discount the possibility, Christofilos's original idea of an antimissile defense might still become a reality through Willow.

Discussions regarding Willow had been going on since at least the previous year, and estimated budgets were being prepared for it as early as January 1959, calling for $60 million for the project. That already high preliminary price tag didn't include money for the missiles and launch support facilities, which didn't bode well for the future of the entire enterprise, particularly since the 1960 AFSWP/DASA budget appropriation was only $17 million.[16]

With the moratorium in effect, DASA and the military continued to debate Willow, and somewhat quixotic efforts to keep it alive would drag on until about the end of the following year. "One could hardly make a persuasive case for a project which, if nothing changed, would never be productive," observed the DNA history.[17] Whether the test moratorium was continued for another year or ultimately led to a permanent test ban, Willow could probably never be conducted. For the time being, at least, the weaponeers would have to wait.

The scientists, however, didn't have that problem, and continued to pore over their Argus data. Later in the year, Army Signal Corps scientists announced evidence of a second Argus radiation shell in their analysis of the Explorer 4 data.[18] If the military and strategic potential of Argus had been stalled somewhat by the test moratorium and political obstacles, the scientific bounty was there to be reaped.

But the military contingent was about to get some encouraging news. On December 29, 1959, reluctantly yielding to pressure and hoping that it might kick start the Geneva test-ban talks with the USSR that had stalled over technical issues, Eisenhower announced that the US would end its "voluntary moratorium" as of December 31, though it would not resume actual testing without giving public notice in advance. The Soviets responded that they would refrain from testing as long as the US did likewise.

For the weaponeers, it wasn't yet a return to the glory days, but it gave hope that perhaps they might soon be back in the game. Another sign came less than two months later on February 13, when France tested its first atomic bomb in the Saharan desert and became the world’s fourth nuclear power, following Britain’s first test in 1952.

Clearly, despite the best efforts of disarmament advocates and the prevailing tides of world opinion, the era of nuclear testing was not yet past. Whether it would resume its frantic pace of the past ten years in the open air of Earth, be driven off the planet into space, or banished deep underground remained to be seen.

CHAPTER 13

A Pause to Consider

WITH THE EISENHOWER ADMINISTRATION ENTERING ITS FINAL YEAR AND A PRESIDENTIAL election on the horizon, nuclear testing and the Cold War in general seemed to have settled into an uneasy lull. Nikita Khrushchev’s visit to the United States in the fall of 1959 had gone well and seemed to augur an easing of tensions, but there were major issues between the US and USSR yet to be resolved, such as the test ban treaty. The Geneva talks continued fitfully with US negotiators struggling to develop new strategies for dealing with the Soviets, but it was becoming increasingly probable that any substantial breakthroughs would have to wait for the next administration. Still, Eisenhower and Khrushchev were planning a summit meeting for May 1960 in Paris, and perhaps progress there would translate to other areas.

Meanwhile, the nuclear testing establishment kept itself occupied at a greatly reduced but steady pace. Scientists at the weapons labs still had mountains of data from all the tests of 1958 to analyze, and at the continental test site in Nevada, there were other non-weapons projects to keep things humming along. The AEC and NASA worked on experiments for Project Rover, with the aim of creating a nuclear-powered spacecraft, while the Air Force busied itself with Project Pluto, a nuclear ramjet cruise missile. Such efforts involved the use of nuclear reactors and radioactive materials, but not nuclear explosions, so they were fair game whether the test moratorium was considered in force or not. Livermore continued low-level work on Plowshare, their pet project for the use of atomic explosions for civilian purposes such as digging mine shafts and creating harbors. Although the moratorium prevented full-scale experiments involving Plowshare ideas, Livermore scientists were free to test concepts with conventional high-explosive devices at the Nevada Test Site. And it was also possible to continue technical work on finding ways to detect nuclear explosions through seismic and other kinds of sensors, research that was directly relevant to the Geneva test-ban negotiations.

“Tunnels were dug. Contractors kept working. Radiation safety and weather groups remained in place. Overall, a level of readiness was maintained so that nuclear weapons testing could successfully resume when needed,” noted a DOE history, also observing that “the moratorium was not entirely unwelcome in the testing community. After a record seventy-seven nuclear weapons tests in 1958, the testing system, noted one participant, ‘was tired, tired, tired.’”[1]

Ever restless, Nicholas Christofilos had already moved on from Argus, continuing work at Livermore on his main passion, the Astron fusion reactor, and supervising construction of a linear accelerator to test Astron concepts. Turning away from outer space to the depths of the oceans, he had also devised a system for communication with submarines using extremely low frequency radio waves.

He was also undergoing some profound personal changes. His divorce from Elly became final in May, and at the end of June he married a coworker from Livermore, Joan Jaffrey, in Chapala, Mexico.[2] It would not prove to be a happy ending, however, as the emotional and legal fallout from the divorce would persist for some time to come.

James Van Allen was also deep into new projects and space missions, but still found himself talking and writing about Argus. Whether consciously or not, he continued to downplay the military aspects of the enterprise in favor of the scientific. Speaking at Ohio State University early in 1960, he echoed what had now become the standard Argus line, calling it “one of the greatest experiments in pure science ever conducted.” At the same time, noted Walter Sullivan, “he spoke out strongly against its secrecy, which he termed a ‘masterpiece of administrative stupidity,’ for when the project finally became known, it appeared to be ‘a sinister sort of military experiment,’ instead of the great scientific achievement that it was.”[3]

Despite such protestations, none of the direct participants in Argus such as Van Allen, nor those who had been more indirectly involved, as Sullivan had, harbored any illusions about the dual nature of Argus. Sullivan, still with the *New York Times*, had begun work on a book about the International Geophysical Year, and decided to devote an entire chapter to Argus, knowing a good story when he’d broken one. Van Allen was among the many experts Sullivan contacted for help and to read over drafts. Sullivan would also include a detailed account of just how he and Hanson Baldwin had broken the

Argus story and the challenges of dealing with the byzantine world of government secrecy and official classification.

Unlike his colleague Hanson Baldwin, Sullivan apparently had no second thoughts about his role in revealing a classified story to the public. In one of his letters to Van Allen, he commented, “Yesterday I received the text of a talk you have recently given to some engineers in which you discussed the security aspects of Argus with forthright candor and also referred to a new, exciting—and secret—experiment to be carried out in space. I can only say that this time there is no soul-searching going on at the *New York Times*.”[4] The “secret experiment” Sullivan refers to is unknown, but the jaded attitudes of both men about the vagaries of government classification comes through loud and clear.

As part of his research, Sullivan also tried contacting those who may have been the great invisible, if unwitting, audience for Argus: the inhabitants of Tristan da Cunha. In March 1960, he sent letters to both the current British administrator, P. A. Day, and the one present during the time of the Argus shots, G. Francis Harris, inquiring about whether they or other islanders had seen anything unusual.

The mail service to the ostensible “farthest place on Earth” was painfully slow, so Sullivan’s inquiries didn’t reach the island until July—which turned out to be the first time that anyone on Tristan da Cunha had heard anything about Argus. “When the letter reached the island … its 294 inhabitants learned for the first time that on Aug. 27, 1958, an atomic bomb was fired sixty miles south of their island,” Sullivan later wrote in the *New York Times*.

In his response, which Sullivan didn’t receive until October, Harris recounted how the islanders had indeed noticed some strange things going on during that brief but odd summer of 1958, including the occasional passing Navy aircraft and mysterious shortwave transmissions. Somewhat more ominously, current administrator Day’s response to Sullivan included observations of fallout measurements on the island having increased to about three times their normal levels from late summer to October 1958. Sullivan checked with an expert at the New York AEC office, who told him that the brief rise in readings at Tristan was most likely not related directly to Argus but was simply a result of increased fallout all over the world during that period, given the high number of US and Soviet tests that had occurred that year: “October [1958] was a pretty darn meaty month all over the world,” said the AEC. There may have been a slight increase in fallout at Tristan from the first Argus shot, but "probably slight compared to the general world-wide increase at that time."

It seemed hard to believe that anyone could be unaware of atomic bombs going off in their own backyard, but as Sullivan explained, "Official word of the staging of Project Argus was withheld for some time, and when the news was finally printed the location of the atom shots was not revealed. Hence the islanders and their British administrators may have heard about Project Argus without relating it to the September flight of planes over their island."[5]

WHATEVER HOPES STILL REMAINED FOR EISENHOWER TO ACHIEVE A TEST BAN treaty or a more permanent detente with the Soviets evaporated on May 1, when an American U-2 spy plane was downed over Sverdlovsk and its pilot, Francis Gary Powers, was captured alive. Khrushchev was genuinely outraged, considering the incident a betrayal of the goodwill he believed he had been building up with Eisenhower. But more than that, he also recognized a golden propaganda opportunity, which he proceeded to exploit to the fullest. The initial US denials, disproved by the capture of Powers and the U-2's reconnaissance equipment, didn't help. Eisenhower refused to accede to Khrushchev's demands for an apology, and the Paris summit rapidly collapsed in rancor and recrimination. A disappointed Eisenhower had to return home knowing that he had failed in his great dream to leave a legacy as a peacemaker.

Fortunately, the U-2 affair didn't completely destroy prospects for a test ban treaty. In the wake of the episode, both Eisenhower and Khrushchev reaffirmed their commitment to pursuing disarmament. The talks continued in Geneva, but with the atmosphere chillier than ever. The spirit of trust, or at least wary friendliness, that had been slowly blossoming between the US and USSR had vanished, and it would be left to Eisenhower's successor to pick up the pieces.

One of the many contentious issues in the Geneva talks was the problem of verification: if both sides did agree to stop testing nuclear weapons, how could they be sure the other side wouldn't cheat? In other words, was it possible to set off a nuclear explosion without anyone knowing about it? As Sullivan had discovered in his correspondence with the Tristan islanders, it was at least theoretically possible, since apparently they hadn't known about Argus until he told them about it. But if anyone on Tristan had happened to be awake in the middle of the night and looking up at the time of an Argus shot, they may have seen something.

It was clear that atmospheric tests in the open air wouldn't escape scrutiny for long. Even if they were conducted in a remote enough location, fallout debris would inevitably spread around the world for anyone to detect; indeed, that was how the US had initially learned about the very first Soviet A-bomb. And since one of the major motivations for a test ban was to stop atmospheric testing and the spread of fallout, detecting such tests wasn't really an issue. The sticking point was whether tests deep underground or at very high altitudes—in the upper atmosphere or outer space—could be effectively concealed. A joint US-Soviet conference of scientific experts in summer 1958 had concluded that methods for detection of clandestine testing were largely reliable, which helped convince both sides to undertake the temporary moratorium.

The prospect of policing a permanent test ban was still daunting. Detecting underground tests with seismometers posed the problem of distinguishing a nuclear detonation from natural earthquake activity. Detecting high-altitude tests might be possible with satellites or earth-based means, but it wasn't as straightforward as it seemed.

Some disquieting news also came out of the Soviet Union near the end of 1960, when Russian geophysicist Valeria I. Troitskaya, who had headed the Soviet IGY effort, reported that her analysis of data from various Soviet "telluric current" monitoring stations had picked up unmistakable signs not only of the Argus shots but also of the Orange high-altitude H-bomb test in the Pacific. Troitskaya's work had already demonstrated that magnetic storms caused by solar activity can "twang" the natural geomagnetic current in the Earth's crust. As her detectors demonstrated, the Argus shots and Orange had done essentially the same thing. The data pinpointed both the times and the locations of each detonation, and the publication of Troitskaya's data was in fact the first public announcement of the actual shot times. "Dr. Troitskaya pointed out … the official times given by the United States for the shots erred somewhat. This, according to scientists associated with the project, was so because they were required, for security reasons, to make the times approximate," reported Sullivan in the *New York Times*.[6]

Although the Soviets hadn't realized the true nature of their odd geophysical observations at the time, the reality that they had in fact detected the supposedly secret Argus shots was not comforting to Pentagon officials. But for those working and hoping for a permanent test ban, it provided further evidence that cheating would be readily uncovered. It did not help to resolve debates in Geneva over other issues, however, such as on-site inspections and yield limits for underground tests. The negotiators soldiered on, even as John F. Kennedy won the November election and Dwight D. Eisenhower prepared to leave office.

In his farewell address to the nation on January 17, 1961, Eisenhower famously warned against the excesses of the "military-industrial complex," lamenting the fact that while in the past the United States built weapons only in times of war, in the new atomic age "we have been compelled to create a permanent armaments industry of vast proportions." In an often overlooked corollary to his warnings of the "undue influence" of the military, he also spoke of "the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite." Ironically, though perhaps with the best of intentions, Eisenhower himself had done much during his presidency to foster and expand both.

That irony did not escape the wise old warrior and statesman. Mentioning the imperative of disarmament, and with the failure to achieve a permanent nuclear test ban weighing on him, he said, "I confess that I lay down my official responsibilities in this field with a definite sense of disappointment. As one who has witnessed the horror and the lingering sadness of war, as one who knows that another war could utterly destroy this civilization which has been so slowly and painfully built over thousands of years, I wish I could say tonight that a lasting peace is in sight … so much remains to be done."

The work of achieving "a lasting peace" would now fall to John F. Kennedy. He took office as something of a contradiction, part "peacenik," part dedicated Cold Warrior. Although he had campaigned against a nonexistent "missile gap" between the US and USSR, and now promised to "oppose any foe" to "assure the survival and the success of liberty," proclaiming that "only when our arms are sufficient beyond doubt can we be certain beyond doubt that they will never be employed," he also called for "serious and precise proposals for the inspection and control of arms." During his years in the Senate, Kennedy had been a strong and outspoken supporter of a nuclear test ban, and many test-ban advocates were confident that the new president would finally achieve that goal.

The Soviets also seemed reasonably optimistic and receptive to renewed discussions. Nikita Khrushchev himself began pressing for a summit meeting with Kennedy even before the new president was inaugurated. For a brief but heady moment, the “New Frontier” seemed to be more than lofty rhetoric. And although both sides had publicly declared themselves no longer bound by the testing moratorium, they were continuing, quite voluntarily, to observe it anyway, based on a gentleman’s agreement of “I won’t do it unless you do it first.”

Meanwhile, not everyone was happy with the new administration. The Pentagon and the AEC were growing increasingly restive, uneasy with the ongoing moratorium, fearful about falling behind the Soviets, worried about hanging on to their scientists, struggling to maintain some kind of operational readiness to resume testing while uncertain what form it might take if it did resume. Despite the relentless worldwide public opposition to atmospheric testing that had led to the moratorium in the first place, many in the testing establishment knew that there were no guarantees that the USSR would continue to play along. Perhaps for now, it suited their propaganda purposes to do so, but that could change abruptly. And who was to say that the Soviets couldn’t—or wouldn’t—test in secret while still professing to be observing the moratorium? And if that happened, how badly would it affect American security and the effectiveness of our own atomic stockpile?

Even assuming good faith on the part of the Soviets at present, it was still quite conceivable that for whatever reason the US could decide to resume testing on its own accord. If so, would it be underground? In space? In the atmosphere? Would it take place in Nevada or the Pacific? Both? Someplace else entirely—even back in the frigid South Atlantic? As the Kennedy Administration settled in, such questions were endlessly discussed, both in administration circles and within the halls of the Pentagon and the AEC.

Kennedy’s new team of advisors and cabinet members also debated options for the next round of test-ban negotiations, which, after closing down the previous December to await the new US administration, resumed in Geneva in March 1961. It was not an auspicious start. Perhaps reenergized by the break and deciding to test the mettle of the new administration, the Soviets assumed a tough stance, rejecting American proposals on verification and inspections and offering problematic counterproposals. Any hopes for a quick and substantive breakthrough were quickly dashed.

Matters only grew worse as spring turned to summer. The abortive Bay of Pigs fiasco in April didn’t help US-Soviet relations, nor did the first meeting between Kennedy and Khrushchev in June in Vienna. The young president tried to hold his own against Khrushchev, but the domineering chairman seemed to largely overwhelm him, especially as Khrushchev issued an ultimatum on the long-troublesome Berlin situation. Kennedy left Vienna feeling demoralized, while Khrushchev went home newly confident. Before the summer was over, the Berlin Wall would be raised, and two months after that, US and Russian tanks would confront each other in a brief but tense standoff at a border checkpoint between East and West Berlin.

After all the hope and optimism with which 1961 had begun, it was hardly the climate for sweeping disarmament agreements. As if to emphasize the point, the USSR finally decided to abandon the test moratorium. On August 30, they announced that they would resume testing, laying the blame squarely on the United States for its failure to accept its supposedly reasonable proposals for the test ban and disarmament. The Soviets proceeded to conduct their first nuclear test since 1958 two days later—in the open air. They followed that up with more tests, with no concerns about fallout or public reaction. (In response to accusations that they had broken the moratorium, the Soviets had a convenient loophole: they pointed out that they had only pledged not to test as long as the “Western powers” did likewise—and that “Western powers” included France, which had indeed continued to explode bombs quite independently in utter disregard of any US-USSR agreements.)

Kennedy’s reaction, reported his special assistant and speechwriter Ted Sorenson, was “unprintable.” He had tried to avoid it for as long as possible, but politically, practically, and militarily, he no longer had a choice. On September 5, he announced that “In view of the continued testing by the Soviet Government, I have today ordered the resumption of nuclear tests.” But Kennedy still had a political card to play. The new American tests would only be conducted “in the laboratory and underground, with no fallout.” The USSR might be cavalier about nuclear fallout and world opinion, but not the US. “We have taken every step that reasonable men could justify,” said Kennedy. “We must now take those steps which prudent men find essential.” He also noted that “our offer to make an agreement to end all fallout tests remains open until September 9.”

Underground tests resumed in Nevada ten days later under the name of Operation Nougat. Compared to the renewed Soviet activity, it was a fairly modest effort, though the weapons labs and test personnel were pleased to be back in business. Unfortunately, Kennedy’s promises about “no fallout” didn’t quite pan out: some of the Nevada tests nevertheless ended up venting some radioactive debris from their underground tunnel shafts into the air. Still, it was minor and limited only to the immediate vicinity, unlike the product of the new multi-kiloton and megaton Soviet tests.

That disparity, however, started to grate on some within the testing community. Why should the United States continue to restrain itself while the Soviet Union had resumed open testing of all sorts of large, dirty weapons aboveground without any regard at all for the rest of the world? Aside from that nagging question, there continued to be new weapons designs and problems that could only be effectively resolved with the testing of larger devices, either aboveground or at high altitudes. Pressure began to build on the Kennedy Administration to return to a full-fledged program of atmospheric testing instead of one timidly hiding away in deep underground caves and tunnels.

All of these alarming developments had not escaped the notice of American popular culture. In the midst of international tensions, a minor yet oddly appropriate movie was released in July of 1961 called *Voyage to the Bottom of the Sea*. Directed and co-written by Irwin Allen, previously known mostly for nature documentaries and an adaptation of the Arthur Conan Doyle novel *The Lost World*, *Voyage* centered on the advanced scientific research submarine USOS *Seaview*, designed and built by genius scientist and engineer Admiral Harriman Nelson. When meteors ignite the Van Allen radiation belts, lighting a fire in the sky all over the world that begins to melt the polar ice caps and literally cook the entire world, Nelson devises a plan to use the *Seaview* to save the Earth by launching a nuclear missile to explode within the belts, extinguishing the fire and presumably wiping out the belts as well.

Although a scientifically preposterous scenario, Allen’s fanciful premise is oddly reminiscent of Project Argus. Unlike Argus, Nelson’s scheme is quite public and vocally opposed as too risky by many scientists and governments, forcing an obsessive Nelson to evade various obstacles before he ultimately achieves his mission and saves the planet. It’s unknown whether Allen and his co-screenwriter Charles Bennett were directly inspired or influenced by Argus in conceiving the story, but it’s likely that they were at least aware of the project, and attempting to tie in their film with current newsworthy events, including not only Argus but also the International Geophysical Year, nuclear testing, and especially the recent launch of the world’s first nuclear submarine USS *Nautilus*, using the canny commercial instincts on which

Allen built his subsequent career in film and television. (And of course, the film’s themes of worldwide catastrophe, melting icecaps, and attempts to stave off worldwide climate change in the face of political denial and opposition have a sad new relevance in the twenty-first century.)

While hardly the equal either artistically or technically of other contemporary films involving themes of nuclear testing and weapons, such as 1959’s highly influential *On the Beach*, *Voyage to the Bottom of the Sea* (which spawned a successful television series several years later) is an intriguing cultural artifact of a tense era, a moment in history in which imminent catastrophe seemed to hang over the entire world, not in the form of a burning sky but of nuclear Armageddon. Although neither Irwin Allen nor almost anyone else realized it at the time, his potboiler film would prove eerily prescient of the very near future, if not to such an apocalyptic degree.

The sequel to Project Argus was about to be born.

CHAPTER 14

Bigger Bangs

ON OCTOBER 30, 1961, THE LARGEST EXPLOSION EVER CREATED BY HUMANS occurred over the remote Arctic archipelago of Novaya Zemlya. It was a hydrogen weapon called the Tsar Bomba, designed, built, and tested by the Soviet Union with an announced yield of fifty megatons, but actually somewhat higher than that, with later analyses revealing a yield of fifty-seven megatons. Though the bomb had originally been designed to create a 100-megaton explosion, that was apparently too much even for the Soviets, who modified the weapon for a lower yield after realizing the amount of fallout such a weapon would create, not to mention the fact that it would certainly immolate the bomber crew dropping it and even from that desolate location possibly kill or injure a number of Soviet citizens. It was the ultimate in saber-rattling.

It did not come as a surprise. That past summer, Khrushchev had already warned that the Soviets might test a 100-megaton weapon, and earlier in October he had announced his intention to test a fifty-megaton version of that weapon. But the advance warning did little to diminish the political—and physical—impact of the test.

Even in its more modest form, the bomb's effects were felt around the world. Buildings were damaged and windows shattered hundreds of miles away, and the seismic shockwaves traveled around the world three times, echoing both the voice of doom and the defiance of the USSR.

Despite all the wrangling in Geneva about test detection and cheating and on-site inspection, this was not the sort of test that could be kept secret. Nor was that the point. Nikita Khrushchev had intended it as a demonstration of his country's strength, determination, and stubborn independence. And on a more visceral level, Tsar Bomba was simply meant to scare the world. Khrushchev wasted little time in boasting of the Soviet achievement and warning that the USSR possessed far more powerful weapons.

As might be expected, worldwide reaction outside the Communist bloc was universally negative. It wasn't only the monstrous scale of the weapon—seemingly beyond any reasonable military purpose—but the callous disregard of the fallout from such an enormous detonation, particularly since the USSR had voluntarily refrained from atmospheric testing for almost three years previously (though they had resumed almost two months before Tsar Bomba). The Vatican called the test "an insane decision, morally, politically, socially, economically, and humanely deprecable," that had shown the world "the true face of Communism … reflecting the tension of hatred." The Norwegian Parliament, geographically closer than most to the site of the detonation, declared that it "showed a cynicism unparalleled in history," while West Germany accused the USSR of "ruthlessly risking the health of all mankind."[1]

The US was also critical. Former presidential candidate and outspoken test-ban advocate Adlai Stevenson, now US ambassador to the United Nations, proclaimed that the Soviet Union had "started a new race for deadly weapons."[2] Also predictable was that this latest Soviet provocation increased by orders of magnitude the pressures upon Kennedy to resume testing in the atmosphere, rather than limit the US to innocuous "no fallout" underground detonations. After all, if the Soviets weren't going to restrain themselves, why should the United States?

Also, the problems that had arisen during the extended moratorium—such as maintaining test capability and resources—hadn't gone away, even with the resumption of underground testing in Nevada. And the labs continued to insist that certain categories of new weapons and their effects couldn't be effectively evaluated without full-fledged atmospheric testing. Opinion was almost unanimous that, as presidential assistant Arthur Schlesinger later wrote, "This final atrocity made it impossible to put off our own preparations for atmospheric testing any longer."[3]

Still, a reluctant Kennedy continued to resist. Although he announced shortly after the Tsar Bomba test that the US was preparing to resume atmospheric testing "in case it becomes necessary," and approved funds for such preparations, he balked at issuing final, definitive approval. Even in the face of domestic and international outrage over Soviet testing, he met opposition from certain quarters, most notably from British prime minister Harold Macmillan. That was a major difficulty, since test planners had decided that with the deteriorated resources of the US's former Pacific testing sites, new tests would require a fresh site: Christmas Island, which happened to be British territory. In a December summit meeting with Kennedy in Bermuda, Macmillan agreed to go along with the resumption of US atmospheric tests and the use of Christmas Island, as long as the US made one more sincere attempt at Geneva to achieve a test ban treaty.

That seemed to clear the path to resume, but Kennedy continued to drag his heels. His new AEC chairman Glenn Seaborg, who was, naturally, deeply involved in the discussions, wrote that "following the Bermuda summit, the decision to test in the atmosphere seemed to have been made. Yet two more months were to elapse before the decision was announced. During this period the president repeatedly sought reassurance, in meeting after meeting, that it was the right thing to do, that there was no alternative … what Kennedy seemed to hope for was some eleventh-hour agreement with the Russians that would make testing unnecessary."[4]

Alas, it was not to be. On March 2, 1962, Kennedy gave a lengthy address to the nation outlining the reasons for deciding to resume atmospheric testing. "It was as though he were addressing the judgment of history," Seaborg noted.[5]

Kennedy discussed the continued Soviet tests and the technical and military gains they were achieving, and explained that resuming US atmospheric tests would make the Soviets realize that the United States would no longer sit idly by and allow the USSR to catch up and surpass us—which might make them more open to further negotiations and the long-sought test ban treaty. Furthermore, he said, "If the Soviet Union should now be willing to accept such a treaty, to sign it before the latter part of April and apply it immediately—if all testing can thus actually be halted … there would be no need for our tests to begin."[6]

The Geneva talks resumed a couple of weeks later, but the impasse continued with the Russians over technical and verification questions. The United States moved ahead with its preparations in the Pacific, including at Christmas Island, where the UK had officially granted access more than a month earlier.

The new series, officially dubbed DOMINIC, would be an ambitious, wide-ranging operation, with thirty-six shots planned, from airdrops to weapons on barges and towers, and the first operational test of the Navy's new Polaris submarine-based missile system. As if to make up for lost time since the interminable moratorium, it would be the largest nuclear test series yet conducted by the United States. And in a major part of DOMINIC called Operation Fishbowl, the US would once again detonate nuclear weapons in outer space for the first time since Argus. But this time, the project would be conducted without the same constraints and uncertainties. The Argus/Christofilos effect was real. What could be done with it? It was time to extend the intriguing results of Argus into an entirely new level of power and technical ambition.

The Fishbowl events wouldn't be the first nuclear detonations in space since Argus, however. As part of their busy operations since abandoning the test moratorium, the Soviets had already fired several high-altitude shots, including at least one experiment in which they fired a missile through the fireball of another detonating warhead to observe and measure the effects. That was disquieting for Pentagon planners, since it indicated that the Russians were aware of the possibilities of "fratricide"—the inadvertent destruction of one warhead by another aimed at the same target—and trying to find ways to either mitigate it or use it to advantage.

"One of the grave concerns felt by the administration about the Russian tests of 1961 was that they might have made progress toward an antimissile missile," said Seaborg. "It was evident from our analyses of the tests that the Soviets had made an effort in that direction. The implications of this were frightening. If one side could prevent penetration by the other side's missiles it would have achieved an enormous and tempting advantage."[7] Further high-altitude tests by the US were needed to keep pace.

Planning for Fishbowl had been in progress for quite a while before Kennedy announced the resumption of US atmospheric tests. Anticipating that possibility not long after the Soviet fifty-plus megaton supertest, he had ordered the testing facilities to make serious preparations, including the establishment of a new joint military task force to conduct tests in the Pacific. Joint Task Force 8 (JTF-8) was formed under the command of Army Major General Alfred Starbird. To command the naval forces of JTF-8, Starbird tapped Argus veteran Rear Admiral Lloyd M. Mustin.

"There was a lot of scurrying around the Navy Department to see who would be the Navy deputy," Mustin remembered in an interview. "Well, I had never had any interest in being involved in the nuclear weapons business, in any way … But people began looking at me pretty closely because of that Argus business."

Mustin wasn’t happy about the idea. “Nobody wanted the job,” he said. But as it happened, he was the only naval officer with the necessary rank and experience. “I said, ‘I’m pretty sure that I can do the job, but it’s certainly not something I’m asking for.’” But “be that as it may,” orders were orders, and “I found myself ordered to be the Navy deputy of Joint Task Force Eight.”[8]

Mustin would not be quite as directly involved with the high-altitude Fishbowl tests as he had been with Argus, however. The shots would be launched by Thor missiles, placing them under the aegis of the Air Force part of JTF-8. A preliminary planning document was already completed in November 1961, months before Kennedy actually gave formal approval for DOMINIC and Fishbowl to proceed. Long before then, plans and proposals for additional high-altitude tests had been under discussion, stalled at first by the test moratorium and later by Kennedy’s reluctance to resume testing. But now speculation and possibility had become reality.

According to the initial November 1961 plan, Fishbowl would consist of three shots: Bluegill, Starfish, and Urraca, each at different altitudes and nuclear yields, all launched by Thor boosters from Johnston Island, the same place from which Teak and Orange had been launched in 1958 and the only spot in the Pacific with the necessary launch facilities. (Conveniently, it was US sovereign territory, avoiding the need for any pesky negotiations with allies.) The objective was to further study and define the various intriguing phenomena that had been revealed by the earlier Teak, Orange, and Argus tests, and to evaluate their defensive—and offensive—military implications. The earlier tests had been interesting, but as a Pentagon official commented, “poorly instrumented and hastily executed,” such that the data provided by them, including Argus, was of only limited value. But a series of dedicated high-altitude tests, carried out with all the elaborate instrumentation, measurements, and control of a laboratory experiment, would fill in all the blanks and answer all the questions remaining from 1958.

“It had begun to become desperately clear that there were, indeed, all sorts of results to be expected from detonations at altitude that we simply had to have information on,” Mustin recalled. “They could be of catastrophic proportions on a national basis, if they were not adequately known, so that adequate considerations could be made for them.”[9]

One of those considerations was what came to be known as EMP, or electromagnetic pulse. Although the existence of EMP as part of the phenomena accompanying a nuclear blast had been known to scientists almost from the beginning of the atomic age, it had been considered a relatively unimportant side effect compared to blast, radiation, and the other far more obvious phenomena. But the Teak event in 1958 had started to change minds, and Orange and Argus only served to convince more people that EMP was something that had to be better understood. “I had never even heard the term during [Argus], but in the interim, some pretty alarming possibilities had begun to be recognized in this country,” Mustin said. Such as knocking out the entire US power grid and communications network “by one single nuclear burst above Kansas, or some such thing.”[10]

Another consideration involved the possibility that the intense X-rays generated by a high-altitude or outer space nuclear burst, unimpeded by atmosphere, might cripple or destroy enemy warheads—a sort of extension of Nicholas Christofilos’s original idea. If so, perhaps defensive missiles could be designed to maximize their X-ray output for better efficiency and killing power.

So there was much to learn, much to catch up on, all driven by the omnipresent Cold War fear that the Russians would learn it all first and go on to use it against us. Now armed with the president’s reluctant approval and full authority, preparations moved ahead quickly, if not smoothly. Getting the vast American nuclear testing machine fully back up and running after such a long layoff, especially for such an ambitious and extensive enterprise as DOMINIC, proved to be a daunting task. Under the pressures of an impending deadline, Project Argus had managed to go from an odd idea in the mind of an eccentric scientist to a successfully completed operation in less than a year. But DOMINIC dwarfed even the massive undertaking that was Argus. And while Starbird, Mustin, and the various other planners of DOMINIC weren’t facing the same deadline pressure of 1958, they did have orders to be prepared to begin testing anytime beginning in April of 1962.

There were facilities to be built, observation stations and instrumentation to be set up, equipment to be moved, and endless administrative and logistical problems to be resolved. Somehow, it all got done, and Operation DOMINIC opened on April 25, 1962, with Adobe, the first airdrop shot at Christmas Island. More tests followed in short order, including the first firing of a live nuclear-armed Polaris missile from a US Navy submarine, the *Ethan Allen*. Making a return appearance in that operation was the Argus veteran USS *Norton Sound*, now serving not as a missile platform but as Admiral

Mustin's flagship for the operation. Immediately after the Polaris test, the *Norton Sound* returned home to Port Hueneme, her cameo appearance in DOMINIC completed, and with it, her career in nuclear test operations. The vessel continued to serve as a testbed for various Navy weapons systems until finally decommissioned in 1986.

Meanwhile, as preparations for the high-altitude Fishbowl tests continued over at Johnston Island, some decidedly nontechnical complications arose. One of them, which had already been somewhat taken into account in the planning of the operation, was the eyeburn problem. Detonating a nuclear weapon at high altitude meant that the intense light of the fireball would be visible over a much broader area than in a surface or tower shot, thus exposing civilians far removed from the test area, even as far as Hawaii, to the possibility of temporary or permanent eye damage if they happened to be looking in the wrong direction when a bomb went off. The problem had first been recognized back in 1958 with Teak and Orange, when some native islanders had been affected. But the Fishbowl events would occur at much higher altitudes, exposing a much wider area to danger. Aside from choosing the most remote and sparsely populated location possible for the tests and evacuating any potentially affected areas, the only solution was to make certain no one strayed into the danger area around shot time. That task would fall to the Navy's patrol planes and ships.

Another complication was more political and thus, less easily resolved. As had been the case ever since both the USSR and US resumed testing, protests had commenced worldwide. Three thousand people demonstrated in Tokyo after the first DOMINIC shot, and 350 protesters were also arrested on the other side of the world at the US embassy in London. On April 29, President Kennedy hosted a formal White House reception and dinner for forty-nine Nobel Prize laureates and other scientific luminaries, including J. Robert Oppenheimer, the former scientific leader of the Manhattan Project. But another dinner guest, Nobel laureate Linus Pauling, was outside the White House, part of a huge crowd picketing against nuclear testing. Several anti-nuclear advocates even went to more extreme lengths, sailing boats into the quarantined safety zones around the Pacific island testing sites, attracting the attention of Admiral Mustin's ever-patrolling security screen of P2V aircraft and destroyers.

For those in the atomic testing game, such annoyances had become part of doing business. But the announcement at the end of April of the impending high-altitude tests brought protests from an entirely different quarter: the international scientific community. The pioneering British radio astronomer Sir Bernard Lovell, director of Jodrell Bank Observatory, worried that the Fishbowl shots, particularly the test planned for the highest altitude, Urraca, would seriously disrupt or even destroy the Van Allen radiation belts, or at least the inner belt.

“The operators of this project should be restrained by all possible means from this presumption of moral right to interfere with the environment of the earth,” Lovell declared. “A small group of military scientists, unknown and unidentified to the world at large,” were doing nothing less than preparing a “sledgehammer blow at the radioactive environment of the earth.”[11] The influential and persuasive Lovell managed to convince a large contingent of scientific colleagues, mostly British and European, that Fishbowl should be stopped, or at least delayed until the possible consequences could be thoroughly and properly examined.

As the more conventional atmospheric tests continued unabated in the Pacific, the Fishbowl controversy played out in the press and scientific community. It seemed to degenerate fairly quickly into an Old World/New World tiff, with the stodgy Brits and hidebound Europeans feeling put out over the Yanks insisting on some foolish childishness. Or at least it was portrayed that way, thus conveniently avoiding the real scientific questions that Lovell, astronomer Fred Hoyle, the International Astronomical Union, and others had raised.

Such an attitude wasn’t even strictly limited to this side of the pond. A BBC producer, writing to James Van Allen to thank him for a television interview on the controversy, opined that “It is clear that … there is still a considerable residue of resentment in this country against the Americans’ ability to do things which we can’t afford or haven’t the skill to carry out!”[12] In other words, the objections of Lovell and his colleagues supposedly weren’t the result of legitimate concern, but simply professional and nationalistic jealousy.

Indeed, little of the protest seemed to come from American scientists. While British scientists such as Dr. Martin Ryle from Cambridge University feared that “the Van Allen radiation belt will be so badly bent that it may never be quite the same again in my lifetime,” Americans such as former IGY scientist Richard Porter denied that the Fishbowl tests would cause any lasting damage to the Van Allen belts.

So did the man who had discovered them, James Van Allen himself. Publicly at least, he declared the new high-altitude tests “a magnificent experiment” that “can and will add greatly to the knowledge of all mankind.” As to the concerns of Lovell and his other scientific colleagues abroad about the space tests, Van Allen noted that “within a few weeks I expect we would not be able to tell it had ever happened.”[13] Privately, however, Van Allen was not as confident as his press statements implied. He would soon have cause to regret his sunny facade.

In the weeks leading up to the commencement of Fishbowl, the press remained ambivalent. While Walter Sullivan mused that the tests “may prove to be the greatest show in scientific history,”[14] the *Los Angeles Times* noted that “It is at least possible that an H-bomb this country plans to fire high over Johnston Island in June or July will inflict a grievous wound on the bottom side of the thick radiation zone around the earth.”[15] The *Wall Street Journal* declared that “If indeed any danger is associated with this experiment, there is also danger involved in not doing all we know how to do to explore those reaches of space about which much is conjectured and little is known … after all, the people who believed the world was flat thought it almost sacrilege when Columbus dared to try to prove it wasn’t.”[16] England’s left-wing *Guardian*, however, felt that “a nation has no right to interfere with the environment of the entire earth on no wider authority than its own decision … assurances that all will be well by American scientists, however distinguished, have a tawdry, unseemly ring … [B]y carrying out experiments which affect the whole environment the Americans are setting a series of precedents … [S]ome procedure should be worked out for deciding which global experiments are acceptable and which are not.”[17]

The controversy was persistent enough that Kennedy finally decided to put together a committee to study the question, including Van Allen, Nicholas Christofilos, and other prominent scientists. Under time pressure and constrained to deliberate only on very specific questions, the committee quickly concluded that the Fishbowl tests did not pose any significant problem either to scientific research or to manned spaceflight. Van Allen would later characterize these conclusions as “tentative,” but for the time being, they were good enough for the government to proceed. At a press conference on May 9, in response to a question about whether the upcoming nuclear tests would jeopardize Kennedy’s stated position that the US would conduct only peaceful operations in space, Kennedy responded, “No, I don’t think so. I know there’s been disturbance about the Van Allen belt, but Van Allen says it’s not going to affect the belt, and it’s his!” The reporters laughed.[18]

In the midst of it all, the AEC found itself inundated with letters from concerned citizens, which had either been sent to the AEC directly or forwarded by other government agencies. Finally the Commission’s Deputy Director of Public Information, Philippe Jacques, was forced to devise a form letter in response, addressed “To Those Who Have Inquired Regarding the Van Allen Belts.” Jacques wrote reassuringly, “The reasons for our high-altitude tests over Johnston Island and their importance to our national security, together with the safety aspects of such testing, have been carefully considered at the highest levels of the Government.” He went on to explain that “outstanding scientists, including Dr. James Van Allen, discoverer of the belts which bear his name,” has concluded that any effects from the tests would be minor and would disappear quickly. Also, “none of the possible effects on the Van Allen belts would constitute a health hazard … there is no need for concern about any lasting effects on the Van Allen belts or associated phenomena.” Whatever comfort Jacques had hoped to provide may have been undercut by his remark that “Because these tests are being conducted for the purpose of acquiring significant national security information, it is not possible to reveal all the data concerning the tests.”[19]

A few weeks later, as June began, and Fishbowl was finally about to commence over Johnston Island, all the political, administrative, and technical obstacles seemingly vanished. But as challenging an endeavor as Argus had been, Fishbowl was about to prove even more fraught with adventure and danger.

CHAPTER 15

The Sun at Night

SO FAR IN 1962, EVEN AS THE UNITED STATES CONTINUED TO RAMP UP ITS nuclear testing activities, the Soviets had been unexpectedly quiet. They had conducted an extremely low yield test at the beginning of February, but nothing since. No one expected this state of affairs to continue for very long. Obviously they were simply analyzing data from their 1961 shots and making preparations for a fresh round of shots.

Which didn't mean that the Russians were ignoring US activities. They might be unable to snoop around underground tests in Nevada, but DOMINIC in the Pacific provided a new opportunity to monitor American activity. "There was a Soviet ship, well known to us," Mustin recalled. "It wasn't a trawler; it was a big ship that cruised slowly through the Pacific … it was an intelligence-gathering ship with massive facilities for electronic interception and so on." The vessel had been tracked by Navy patrols at least from the vicinity of Midway Island, and Mustin's planes kept watch on her as she approached Johnston Island. The Soviet ship, however, was careful to stay outside of the restricted waters surrounding the testing sites, an easy task since the boundaries had been made public to all marine traffic as a safety measure. "They stayed out there for a while," Mustin said, "long enough to confirm, to their own satisfaction, that we were detonating devices over there. She was about 500 miles away." At least one of Mustin's P2V aircraft stayed in sight of the Russian spy ship continually, rotating with other planes based on Christmas Island.

It was a hazardous duty, stretching the P2Vs to their limits of range and endurance. One plane was almost lost at sea when it experienced an engine fire. "Those men flying those long over-water patrols were really facing a very real risk every minute they were airborne," Mustin remembered.[1]

JTF-8's scientific deputy, William Ogle, noted that while the British were permitted to make scientific measurements of the Christmas Island shots as part of the agreement for letting the United States "borrow" the island, no such arrangements existed with the Soviets. “The Russians also made measurements with no formal agreement,” he wrote later. “The Task Force and the Commission discussed the subject, but there was really nothing we could do about it except watch and keep fairly close by to make sure that they did not come within the danger area.” Sometimes it was difficult to be quite so tolerant. At one point during a stopover in Fiji, JTF-8 commander General Starbird was dining at a small restaurant and happened to notice the captain of the Russian ship relaxing nearby, apparently taking a break with some of his officers. “Starbird did not want to chance an international incident, and therefore, did not have a discussion with the Captain,” Ogle noted.[2]

Unwanted audience or not, the Fishbowl part of DOMINIC had already begun unofficially on May 2, with the launch of an unarmed Thor missile from Johnston Island. It had essentially been a full dress rehearsal for all the various tracking, monitoring, and experimental stations on land, sea, and air. One of the primary reasons that the Thor missile had been selected, aside from its supposed reliability, was that it had the ability to carry pods which could be released from the missile at predetermined altitudes. Each Thor would carry three of the two-meter-long pods, which contained instrumentation and experimental equipment. After ejection from the booster, the pods would make soft landings by parachute in the open ocean, where they would be retrieved by Navy ships and Marine helicopters. At least, that was the plan.

The May 2 rehearsal, named Tigerfish, went reasonably well, although two of the three instrument pods encountered problems with their recovery systems and were damaged. More dry runs for the various support forces, without any missile launches, followed over the next several weeks. Finally, on June 2, the first nuclear shot, Bluegill, was ready to go.

Shortly after midnight, the Thor missile bearing the Bluegill device was launched. All was going perfectly well at first. The main radar tracking facility for the Johnston Island launches was a ship with the appropriate if not picturesque name *Range Tracker*, which was operated by the Air Force with a civilian crew as part of its Pacific Missile Range. Moored to the Johnston Island pier less than half a mile from the Thor launch pad, the *Range Tracker* had to follow the missile, which was shot into the skies nearly vertically, from almost directly beneath it. “This meant that as the missile climbed on up to hundreds of miles in the sky, with horizontal separation at the ground of a couple of thousand feet, it really required the radar to track very near the zenith, which is a tough problem for a radar," Mustin explained. Somewhere along the way, as Bluegill approached its highest altitude, the *Range Tracker* lost it.

That was a major problem. Somewhere high above the Pacific Ocean with ships and airplanes spread out in all directions, a nuclear-tipped missile was reaching the peak of its ascent as its engine burned out, preparing to plummet back to Earth under the inevitable command of gravity. Without a radar fix, there was no way to know precisely whether the missile was still following its planned trajectory, and thus no way to know where the missile—and its live nuclear warhead—was going to fall. One does not take chances with live nuclear weapons, and there was no time to consider the problem at leisure. JTF-8 commander Starbird gave the only possible order. The range safety officer pressed the destruct button, and the Thor missile exploded, taking Bluegill with it. There was no nuclear explosion, so the entire experiment was a failure. For now at least, the Bluegill shot would have to wait.

Adding to the general consternation over the loss of a valuable missile and even more valuable (but more easily replaceable) nuclear warhead—not to mention the failure to collect any of the desired data—was the discovery that Bluegill had actually been on its proper trajectory, as subsequent data analysis proved. Although there had been no way for Starbird, the range safety officer, or anyone else to know it at the time, there was no need to press the destruct button. Starbird reported as much to Washington in a terse cable two days after the incident: "Preliminary evidence available indicates that the Bluegill missile probably flew a normal trajectory and, if we could have known this, the detonation could have been made to occur in a place to give a safe firing and successful data." Although he noted that "the warhead-missile system had extensive protective systems in it to prevent any except a high-altitude [nuclear] burst," he had decided that "if I could not know from satisfactory tracking that the trajectory could not target near the ship array, I would not authorize arming of the warhead. Unfortunately, the missile tracking system lost the track before we could secure guarantee of safe trajectory. The missile was not commanded to arm therefore but was commanded to destruct." Looking on the bright side, he noted, "the fact that … the destruct worked in Bluegill as commanded, indicates the firing safety system is sound."[3]

It was a chastening situation for all concerned. "There was plenty of agonizing going on, including some by me after I got into the act, to try and figure out what had gone wrong and what we could do to safeguard ourselves against this," Mustin remembered. One obvious solution was to have more radar coverage. "It turned out that we had a number of resources, right there on the island, which indeed had been tracking this thing throughout its flight. If only they had been asked, they could have told us that it was exactly on course … but nobody had thought of that or made any arrangement of that nature."[4]

Also disappointed were the people who had gathered on the beach at Honolulu watching for Bluegill's nuclear light show. In any case, an official statement assured civilians that the mishap would not "cause hazardous levels of radioactivity in the water" or "constitute a hazard to human health." Perhaps the best epitaph on the anticlimactic debut of Fishbowl came from Ogle as Bluegill's pieces fell into the Pacific: "Best damn dry run we ever had."[5]

While the three instrument pods were recovered from the missile (two of which, it was discovered, had failed to eject properly), nothing else was retrieved. There was nothing more to do but pick up the administrative and operational pieces and continue on. The next shot would be Starfish, planned for June 19. The intervening time would be spent in further rehearsals, including better tracking procedures to prevent a repeat of the Bluegill fiasco.

On the night of June 19, another Thor sat poised on the Johnston Island launch pad, ready to boost Starfish into space. Two of the three experimental pods were replaced by dummy RVs (reentry vehicles) intended to test the effects of X-rays from a nuclear blast on warhead materials, with an eye to decreasing the vulnerability of US warheads. Everyone was optimistic that the snafus of Bluegill had all been adequately addressed.

A few minutes before midnight, Starfish was launched. It flew straight and true into the night for just under a minute, then it all went wrong. The Thor missile sputtered and flared and began going out of control. This time, it was clear that something was dreadfully amiss, and at sixty-four seconds into the flight, the range safety officer again hit the button to destroy the missile and nuclear warhead.

It had still been early in the missile's trajectory, however, and it had not yet moved very far from the vertical above Johnston Island, ending its existence at an altitude of only 30,000 to 35,000 feet. Debris from the explosion fell onto Johnston Island, causing no major damage but creating quite a mess. Parts of the missile, one of the RVs, and the remaining instrument pod were scattered over the island, and more debris fell into the lagoon and surrounding waters of Johnston Island. As the Navy recovery divers soon discovered, some of the junk was contaminated with plutonium from the Starfish warhead.

The cleanup effort consumed the next several weeks. Analysis of the debris along with other data revealed that one of the dummy re-entry vehicles had been the culprit, disrupting the missile's exhaust flow and weakening it until the Thor's engine tore loose and collapsed into the fuel tanks.

The other DOMINIC shots were proceeding apace, but Fishbowl was beginning to look decidedly jinxed. Fixing the problem that had caused the destruction of Bluegill had done nothing to save Starfish from the same fate. And only a limited supply of Thor missiles, instrument pods, and other necessary equipment was available, so continuing to lose them at this rate for no appreciable return was obviously unacceptable.

The displeasure wasn't simply felt by the test personnel, but extended all the way to the top. "These two failures presented us with the problem of what to try next at Johnston Island," AEC chairman Seaborg remembered.[6] Because Starbird had made it clear that to allow time for all the necessary preparations it wasn't possible to conduct further missile shots closer than fifteen days apart, and because Fishbowl had already been operating for more than a month with nothing to show for it, President Kennedy was beginning to ask embarrassing questions, with the implied possibility that the rest of the high-altitude program might be curtailed or even cancelled entirely.

At the end of June, Seaborg visited the Pacific test sites along with several aides and JFK's national security advisor McGeorge Bundy. They watched a shot at Christmas Island and then proceeded to Johnston Island to tour the facilities and, perhaps, to provide a little incentive and encouragement. "We saw the launching pad and the complicated diagnostic facilities operated by the Air Force and several laboratories," Seaborg wrote.[7] Upon his return to Washington, Seaborg sent a message to General Starbird, telling him not to rush the upcoming second attempt at Starfish. The luxury of failure, always a fragile thing in the best of circumstances, was gone. For the next shot, everything had to work.

As discouraging as they may have been, at least the failures thus far encountered hadn't resulted in casualties to anything other than equipment.

For all aspects of Operation DOMINIC, safety had been a prime consideration from the first planning sessions, and continued to be emphasized throughout all operations. No shot, whether on or near the ground, high above, or in space, would be fired unless all weather conditions were good and the potential affected area had been swept clear of any unauthorized or unneeded personnel.

That was relatively easy for the more conventional tests; whether dropped from aircraft, carried aloft by tethered balloons, or detonated underwater, no human being was required to be nearby when the weapon burst into life. But the Fishbowl shots posed a unique problem. Someone had to be there on Johnston Island to prepare and launch the Thor missiles needed to carry the nuclear devices into space. And liquid-fueled missiles such as the Thor were infamous for blowing up when no one wanted them to. Even the crew of a B-52 bomber, sitting mere feet away from a megaton weapon cradled in their bomb bay, were safer than a crew working a half mile away from a megaton warhead sitting atop thousands of gallons of volatile, highly explosive liquid fuel. The rain of debris that had fallen all over Johnston Island from the failed Starfish test was a grim reminder of the possibilities.

There was only one option. “Our practice was to evacuate the island, the late afternoon immediately before the shot, of everyone except those absolutely required for the conduct of the test,” Mustin said. “It soon turned out that the only way to do this was to evacuate them by helicopter to a ship.” Because there might be as many as a thousand people on the island during test activities, that required a large ship, preferably an aircraft carrier.

Mustin first secured the *Iwo Jima*, which was later replaced by the *Princeton*, both carriers that hosted Marine helicopter squadrons to handle the evacuations. “These Marines really made a precisely organized and executed operation of evacuating 2000-2500 [sic] men off the island in a couple of hours,” remembered Mustin. “Of course, it required that the people being evacuated respond precisely to organization and discipline. And this was not something they were accustomed to. They were a heterogeneous bunch of stevedores and cooks and bakers and scientists and engineers, a certain proportion of military, and so on. But the need was apparent and the mechanism was there. The Marines knew exactly how to do their part. It really went beautifully, and we never had an accident in quite a number of evacuations of the island.”[8] Other documents cite the usual complement of evacuees as only around 800, but whatever the number, it was nonetheless an impressive operation.

Once an evacuation was completed, the carrier would move away from the island and out to sea, clear of the trajectories of the warhead-carrying Thor as well as the various instrumented rockets that would be fired for the test. “The main danger, we were told, would not be from the nuclear explosion, but from the barrage of instrumented Nike missiles which would be launched to take readings on the detonation,” recalled one test veteran. “The impact points for these missiles were unpredictable.”[9]

Aside from observing the shot, there was little to do. “Many of the people brought to the ship were relatively highly paid scientists, engineers, etc., who had nowhere to go and nowhere to spend their salaries,” observed a website for Johnston Island veterans. “Rumor has it that many high stakes poker games could be found on the USS *Princeton* as these folks waited for the all clear signal to return to their work stations on the island.”[10]

From its safe vantage point, the carrier became the main observation point and command post, with constant secure communications channels to Washington. Before Fishbowl finally came to an end, the wisdom of the pre-shot evacuation policy would become even more evident than after Starfish.

The second attempt at Starfish, now called Starfish Prime, was ready to go on July 4, a coincidentally appropriate date to get Fishbowl back on track with a huge fireworks display. Unfortunately for happy coincidences, the winds were too high for a safe Thor launch, and the shot was postponed. For the next few nights, the weather was too cloudy over Johnston Island and vicinity, precluding the necessary observations and measurements of the high-altitude fireball. Postponements on account of weather were par for the course in nuclear testing, but in this case, they were becoming particularly frustrating.

Finally, just after 11 PM on July 9, Starfish Prime was launched. Starbird was reportedly so nervous about the outcome that he refused to watch the closed-circuit television of the launch at his command post. But for once, he had nothing to worry about. Everything went perfectly: the launch, the Thor missile, the trajectory, the radar tracking, the launch of the experimental rockets, the positioning and operation of the observation ships and aircraft. Precisely as planned, the Thor missile reached an apogee of about seven hundred miles, then nosed over and began its ballistic trajectory back to Earth. Finally the actual detonation of the 1.4 megaton Starfish Prime device took place at an altitude of about 250 miles.

What followed was perhaps the greatest light show ever seen over the Pacific Ocean. Starfish Prime lit up the entire sky from horizon to horizon, from Hawaii all the way to New Zealand, opening with a flash of white light brighter than the sun, which gave way to intense auroras, shimmering curtains of green, yellow, and red—an awesome, primal spectacle of energy on a scale that dwarfed into insignificance all those who witnessed it.

Mustin happened to be 1200 miles away on Christmas Island during Starfish Prime, but he didn't miss a thing. "I just went out and sat on the edge of the sand dunes there and watched the sky," he recalled, as above him was "a complete unbroken sheet of yellow light."[11]

The civilian spectators back in Hawaii, who had been so disappointed when the previous shots had turned out to be duds, finally had their patience rewarded. Some had been waiting on the beaches, while others were guests of several hotels offering rooftop bomb-watching parties, just as some Las Vegas hotels had been doing for years with the Nevada shots. "Except those in a few isolated areas where rains blotted out the sight, residents on all the major islands of the state saw the explosion," reported the *New York Times*. "The most fortunate observers here were those on the heights overlooking Honolulu. They had a clear field of vision when the blast illuminated the horizon south of the city. The brilliant flash sent yellow fingers stabbing through the broken clouds. Some observers believed the color was greenish. The sky turned pink and then a tomato red. It was Hawaii's second sunset of the day and was visible for nearly seven minutes." The paper also featured before and after shots at Waikiki Beach, showing clearly how the night had temporarily become day.[12]

At Kwajalein Island, 1400 miles west of Johnston, an Air Force major reported that "a brilliant white flash burned through the clouds rapidly changing to a green ball of irradiance extending into the clear sky above the overcast. From its surface extruded great white fingers, resembling cirro-stratus clouds … to be replaced by spectacular concentric cirrus-like rings moving out from the blast at tremendous initial velocity, finally stopping when the outermost ring was 50 degrees overhead. They did not disappear but persisted in a state of frozen stillness. All this occurred, I would judge, within 45 seconds. As the greenish light turned to purple and began to fade at the point of burst, a bright red glow began to develop on the horizon at a direction of 50 degrees north of east and simultaneously 50 degrees south of east expanding inward and upward until the whole eastern sky was a dull burning red semicircle … obliterating some of the lesser stars. This condition, interspersed with tremendous white rainbows, persisted no less than seven minutes."[13] Reports from the launch site back at Johnston Island were similarly vivid, describing multicolored glows, streamers, and discs in the heavens.

Other reports came from civilian planes, such as a Canadian Pacific Airlines in flight to Sydney, Australia. Seeing the sky to the north come alive with fiery auroras, the captain turned the plane to give his passengers a better view. In New Zealand, Fiji, and all over the Pacific, observers marveled at the brilliant flash and the active colorful auroral display that followed. "An interesting side effect was that the Royal New Zealand Air Force was aided in anti-submarine maneuvers by the light from the bomb," noted a later technical report.[14]

There were also official technical observers spread across the Pacific, manning over two hundred stations in Samoa, Fiji, Okinawa, Wake Island, and other remote spots. A *New York Times* reporter was stationed with the Samoa group. "Word of the explosion was greeted jubilantly—and with a sense of relief," he reported. The hours leading up to the test were lazy and relaxed, as the men lounged about house trailers and tents with their instruments. "As the hot and humid afternoon wore on, scientists, technicians and military observers performed the few routine tasks in preparation for the big show, as they had done twice before in vain. Then most just sat and talked or read or had a beer or two as the countdown sounded over the shortwave radio."[15]

And Starfish Prime was felt and observed far beyond the Pacific. In Boulder, Colorado, needles on scientific instruments monitoring magnetic atmospheric and earth currents at the National Bureau of Standards were pegged violently when the device detonated. Similar effects occurred in other labs across the country. "Many American scientists … were amazed at the intensity of the long-range effects," noted Walter Sullivan.[16]

Unlike the situation during Argus, when the number of satellites circling the planet could be counted on one hand, the orbital population had increased considerably during the past four years. Among them was Ariel I, the UK's first satellite (though launched in collaboration with the US at Cape

Canaveral), and Injun 1, the latest satellite from James Van Allen and his crew at the State University of Iowa. Injun 1 would follow in the footsteps of its predecessor Explorer 4 to provide data on Starfish Prime, while Ariel, as well as several other satellites, would soon suffer a less dignified fate.

Not everyone who witnessed Starfish Prime that night responded with awe and wonder. Many natives on various Pacific islands reportedly feared that the sky was literally falling on them, fleeing into churches or other refuges. “Crazy white man!” one Samoan exclaimed. Military and test personnel were supposedly obliged to reassure panicky people. Noted the *Times* reporter on Samoa, “Observers not connected with the nuclear test program felt that much of the commotion among the natives could have been avoided if the Samoans had received more advance information on the nature and purpose of the nuclear experiment.”[17]

Some reactions were less primal and far more political. The American embassy in London was again besieged by demonstrators from the Campaign for Nuclear Disarmament, as it had been since the opening of DOMINIC. The President of Ghana protested to Kennedy in a formal diplomatic note: “Is there no way wherein you … can resolve the present cold war anarchy? Is it not real wisdom to suspend this dangerous arms race until efforts being made for peace … can result in a general disarmament treaty?” Moscow, predictably enough, condemned Starfish Prime as a “crime” committed by US “atom-maniacs.” Proclaimed the Soviet news service TASS, “The United States exploded a nuclear device in space despite strong protests of all mankind … [and] confirmed yet again that it is following the course of whipping up the nuclear arms race.” Meanwhile, noted the *New York Times*, “In contrast to the Johnston Island nuclear shot of 1958 [a reference to Teak], which took Hawaiians by surprise, there was little criticism today of the hydrogen bomb explosion [in Hawaii].”[18]

Regardless of whether the rest of the world was delighted by the spectacle or outraged by its political ramifications, the US test authorities, military, scientists, bomb designers, and support personnel were all enormously pleased. There had been a few minor glitches, of course; a couple of instrument rockets had failed, and one or two experiments hadn’t worked here and there. But all of the major elements had gone well. The smoothness of the entire operation seemed to wipe out all the frustration and disappointment of the previous failures.

It soon became evident, however, that smooth and spectacular as it was, Starfish Prime had been something far more than just another nuclear test shot. Even as the magnificent visual displays diminished and then disappeared from the night skies, and all those involved in the operation congratulated one another and basked in success, the effects of Starfish Prime were not about to leave the stage quickly or gracefully.

Nor were the demons of Fishbowl banished for good. They were, in fact, about to become far worse.

CHAPTER 16

The Haunted Island

THE UNPRECEDENTED LIGHT SHOW OF STARFISH PRIME HAD ONLY BEEN ITS MOST immediate and obvious manifestation, perceptible to anyone under the Pacific skies on that July night. But for those who had long planned, prepared, and finally carried out the operation, it was also the least important part. The purpose of detonating a nuclear weapon high in outer space was not to create pretty fireworks, after all. It was to evaluate its military potential.

The purpose of the entire Fishbowl operation was spelled out on the first page of a preliminary planning document: “The primary objective of the overall series is to obtain data regarding the interference to radar and communication systems produced by a high altitude nuclear burst.” Such data would be useful in more ways than one. Teak, Orange, and Argus had already demonstrated that “blackout has serious implications for critical defense systems such as BMEWS [Ballistic Missile Early Warning System], Nike-Zeus, ICBM penetration and many communication systems, and conversely that its employment may be an effective ICBM offensive tactic.”[1] A later report described Starfish Prime’s major objectives including: “1. Evaluation of missile kill mechanisms produced by a high altitude nuclear detonation; 2. Evaluation of a high altitude nuclear detonation on electromagnetic surveillance capability; 3. Evaluation of the effects of a high altitude nuclear detonation on long range communications,” along with investigations of how such phenomena would affect systems that detected nuclear blasts.[2]

The ionosphere all over the Pacific had received a huge jolt, perhaps comparable only to what it would receive naturally in a major solar storm, with a massive sudden blast of electrons injected into the D layer, the radio-reflecting lowest region of the ionosphere. It was the Christofilos/Argus effect writ large—an electromagnetic disruption of enormous proportions.

As expected, the biggest effect on radio communications was at shortwave frequencies, which are most dependent on “bouncing” off the D layer to travel beyond the line of sight and along the curvature of the Earth. Higher frequency radio communications, such as those used by airliners and television, were less affected this time than by the 1958 Teak and Orange shots. Federal aviation authorities had made plans to ground all civilian Pacific flights for several hours after the test, but it proved unnecessary.

Meanwhile, the 266 scientific stations that had monitored the test now scrutinized the radio and radar spectrum across half the planet, making measurements, conducting experiments, checking propagation patterns. In fact, as the *New York Times* noted, it was “probably one of the most widely observed scientific experiments in history,” in notable contrast to the former “greatest experiment in history,” Argus. But while a large number of those observations “specifically included those frequencies of greatest interest in anti-missile missions,”[3] a classified technical report noted that “Basic scientific studies—of the earth’s magnetic field, ionosphere and radiation belts, for example—will be decidedly secondary.” And while “the effects of the explosions on communications presumably were available to the world to observe and analyze,” the results that might be pertinent to anti-ICBM measures would be more closely held. That was ensured by the fact that “only approximate information about the timing, altitude and energy yield of the nuclear weapons has been or will be distributed. This would be enough for most basic scientific studies but insufficient information for those not in on the tests to gain much knowledge about certain of the military experiments.”[4] It was another lesson learned from Argus: revealing some, but not all, of the scientific data, straddling the line between secrecy and openness.[5]

More lasting effects on the Van Allen belts, if any, would take a little longer to confirm. Most of that data would be coming from Injun 1, TRAAC, Ariel, and perhaps less directly from other satellites—US and otherwise—that happened to be in space. One pioneering spacecraft was about to have a fateful encounter with the aftermath of Starfish Prime.

The day after the shot, another momentous event occurred: Telstar 1, the world’s first dedicated communications satellite, was launched from Cape Canaveral. The first stage of its booster carrying it into orbit was a Thor rocket, nearly identical to the missile that had lofted Starfish Prime the night before. Built by Bell Labs and sponsored by ATT as part of an international effort to create a worldwide communications and television network, Telstar assumed an elliptical orbit with a closest approach to Earth of just under six hundred miles, moving out to about 3600 miles, circling the planet every two and a half hours.

It was an event of international import, especially after Telstar began relaying television broadcasts between North America and Europe on July 23. Since President Kennedy wasn't quite set to go on the air before Telstar was ready, the first live public satellite TV broadcast turned out to be part of a baseball game between the Philadelphia Phillies and the Chicago Cubs from Wrigley Field in Chicago (the Phillies won, 5–3). For perhaps the first time since Sputnik and the dawn of the space age, Telstar demonstrated to the world at large that space travel could have a definite and tangible value that transcended scientific or military purposes.

The satellite quickly became a cultural touchstone. An English guitar band, the Tornados, even scored a #1 single on the US record charts with an instrumental dubbed "Telstar." Unfortunately, although it would live long enough to secure its place in history, Telstar 1 was already doomed to an early demise. "Telstar was dying from nuclear effects while it was #1 on the Hit Parade," wrote Stimson Center co-founder Michael Krepon in a 2011 online op-ed.[6]

With each circuit it made around the planet, Telstar passed through an intense band of electrons generated by the Starfish Prime explosion, an artificial radiation belt just as had been postulated by Nicholas Christofilos and first created and observed with Argus. But the Starfish belt would soon prove to be far more intense—and persistent.

Back on the ground, Starfish Prime made itself known even to those who weren't out partying on the beaches of Honolulu under the summer skies. The electromagnetic pulse (EMP) of the detonation created a massive induced electrical surge in Hawaii's power grid, blowing fuses and instantly darkening about three hundred streetlights on the island of Oahu. Burglar alarms were set off and a telephone company microwave link on Kauai was knocked out. Initial speculations that the streetlights may simply have been automatically turned off by their photocell controls when the sky lit up with daylight intensity were soon disproved on more detailed analysis.[7]

From his own vantage point at Christmas Island, Admiral Mustin witnessed even more dramatic EMP effects. A low-frequency long-wave radio antenna, running from a ground station to a balloon, put on quite a display. “This field of electrical voltage induced on Johnston Island, as a result of that burst, was so intense that great big blue sparks were flying all over the antenna up to the balloon … it was a spectacle that people talked about for a long time. Even the most blasé of the scientists, I think, were seeing things that they had conjectured about, but now they knew they were real.”[8]

As the excitement over Starfish Prime passed and Johnston Island crews busied themselves in preparations for the next Fishbowl shot, discussion and argument continued over the effects of Starfish Prime on the Van Allen belts. Obviously they hadn’t been utterly destroyed as some had feared, nor set afire as in *Voyage to the Bottom of the Sea*, but they had definitely been strongly affected. As were the satellites now regularly passing through the new belt created by Starfish, just underneath the natural Van Allen belts. The British satellite Ariel began to suffer electrical problems beginning only four days after the shot, as its solar panels were steadily being degraded by the high electron flux. Telstar was beginning to experience similar problems. For his own part, James Van Allen told a Cleveland rocket society meeting that while the natural radiation of the Van Allen belts might pose some hazard to manned spaceflight, he doubted that the recent high-altitude nuclear tests would either add much to the danger or seriously disrupt the natural belts.[9]

The next show over Johnston Island and the Pacific would be Bluegill Prime, the second try for Bluegill. By July 24, all was ready, another Thor poised on the Johnston Island launch pad, but bad weather pushed the shot to the next day. It would have to wait until July 25, at about 11 PM.

The Thor missile ignited, but failed to rise off the pad; there was insufficient thrust because of a stuck fuel valve. Then fuel began to burn around the base of the missile and the Thor erupted into flames. To ensure that the dying missile wasn’t about to haphazardly take off out of control with its live warhead, the range safety officer again hit his destruct button, and the Thor, the launch pad, and the immediate vicinity of Johnston Island immediately went up in a titanic—but safely non-nuclear—explosion.

“This time the disaster was even more horrendous,” remembered Mustin, who had been watching through binoculars from a command ship offshore. “This was really an awesome occurrence.” A sailor aboard one of the nearby ships remembered, “I got a real sick feeling knowing that there was a fully active A-bomb on the rocket. It gave a new meaning to ‘Put your head between your legs and kiss your ass goodbye.’ I monitored the countdown and opened the outside hatch (against orders, but what the hell, if it blew, no one would know) when we heard the abort code. Hell of a fireball!”[10]

Fortunately there were indeed no casualties, with the few people still remaining on the island at a safe distance from the conflagration. It was bad enough, however. Even after the fires were extinguished, radioactive plutonium from the destroyed W-50 nuclear warhead was strewn all over the area. Any further launches from Johnston Island would require extensive decontamination procedures and weeks, perhaps months, of extensive repair work to restore the launch pad and support facilities. For the moment, Operation Fishbowl was at a standstill.

For the test personnel—frazzled and overworked from the repeated failures and continuing problems—it was perhaps a welcome break. Aside from those directly engaged in decontamination and repair operations, the Fishbowl portion of the DOMINIC task force withdrew to plan and prepare for the eventual resumption of activity. For the military, AEC, and administration, this latest fiasco posed an embarrassing problem. Fishbowl was already behind schedule, with no chance to be completed by the deadline originally set by President Kennedy—July 25. Which left only two options: cancel the remainder of the planned high-altitude tests, or extend the deadline. The first option meant the loss of valuable data eagerly awaited and desperately needed by the Pentagon and weapons scientists; the second option meant political complications for the continuing test-ban negotiations.

In the end, there was no real choice. Fishbowl would continue. “Although rumors were rampant that the President would call an end to the operation, this was really very improbable,” Ogle later wrote. “On July 22, 1962, the USSR had announced their intention to begin a new series of atmospheric tests. Kennedy was still trying to pressure the Russians about a test ban. Furthermore, in the game of international power it was bad enough for the US to have such publicly miserable failures; it would be even worse to stop the tests, admitting that we could not finish the job.”[11] But even as Kennedy agreed to allow Fishbowl to continue, he demanded it be completed as soon as possible.

After laying low for most of the year, the Soviets resumed their own atmospheric tests at the beginning of August, including a forty-megaton shot that recalled their even larger test of the previous year. For now, until

Fishbowl could be resumed, it would be the United States that was quiescent. Ideally, the remaining Fishbowl tests would be the final US atmospheric shots before a test ban treaty put an end to them all over the world. Or so Kennedy hoped.

As the repairs and cleanup continued at Johnston Island, new plans took hold. Urraca, the high-altitude test originally planned to open the Fishbowl series but repeatedly delayed, was finally cancelled by Kennedy, “both because of its possible effect on satellites and because the President really did not wish to develop another method of testing,” as Ogle described. “His objective was to prevent testing, not to help it.”[12] If conducted, the Urraca test would have been at the highest altitude yet—about five hundred miles, twice that of Starfish Prime. Instead, along with the twice-delayed Bluegill, three new high-altitude shots were added to Fishbowl, named Checkmate, Kingfish, and Tightrope.

Two of those would not make use of the troublesome Thor booster. “People were getting a little touchy about this,” said Mustin. “Questions were beginning to arise: ‘Where’s all that 98% reliability that you Air Force guys told us had been in the record for this Thor missile?’” Aside from questions of reliability, there weren’t a lot of Thor missiles remaining to be used, since it was no longer in production by its manufacturer, Douglas Aircraft. So the low-yield Checkmate and Tightrope tests would be borne by smaller boosters. Air Force officials were quick to emphasize that the recent problems shouldn’t be taken to imply any lack of military readiness on the part of the United States, nor any particular flaw in the missile, since some of the failures were not related to the Thor’s military capabilities.

As they continued their new tests, the Soviets couldn’t resist needling the United States. “On August 11 we received word that the Soviet Union was anxious about the safety of its astronaut, Nikolayev, whose orbit around the earth was expected to last for several more days,” Seaborg wrote. “They sent us diplomatic signals that were essentially appeals not to conduct any tests that might endanger the astronaut’s life.” The State Department assured the Russians that the US wished their cosmonaut well and would do nothing to endanger him.[13] Still, the Russian concerns certainly agreed with Van Allen’s statements about possible hazards for space travelers, specifically an upcoming Mercury flight by US astronaut Walter Schirra.

For the public and other observers not directly involved, the continuing debates about dangerous outer space radiation belts were decidedly confusing. On one hand, respected scientists such as James Van Allen declared that while there could be danger, the Fishbowl tests had caused no lasting damage to the natural radiation belts. On the other hand, official statements from the AEC and Defense Department stated that Starfish Prime had created a new artificial radiation belt that had not only knocked out three satellites so far—Ariel, TRAAC, and a Navy satellite—but that the new belt was stronger than previously thought and might persist for years. Arguments that orbiting astronauts, unlike satellites, would mostly travel at altitudes below the radiation belts were not always convincing.

By October, almost three months to the day after the Bluegill Prime disaster, Fishbowl was finally ready to pick up where it had left off, with another attempt at Bluegill, now called Bluegill Double Prime. Unfortunately, the third time, launched before midnight on October 15, was decidedly not the charm. Less than three minutes after leaving the launch pad, the Thor missile began tumbling out of control, and yet again the range safety officer exercised his prerogative and sent the destruct signal.

It was hardly an auspicious way to resume Fishbowl. “The Thor crews and, for that matter, everyone else were tremendously dejected,” Ogle recalled.[14] Task Force commander Starbird was more than fed up with the Thor by this point, but he had no other ready option for the remaining high-yield shots.

Meanwhile, on the other side of the world, another collection of missiles, this time of the Soviet variety, was causing major trouble in Cuba. Thanks to some timely U-2 reconnaissance photography, President Kennedy was just finding out about the Soviet medium- and intermediate-range missile sites being constructed on Cuba, and he and his advisors were secretly debating how to respond.

For the next two weeks, the world tottered on the precipice of nuclear war, as Kennedy and Khrushchev made move and countermove, struggling to resolve what had become the gravest crisis of the Cold War. American strategic forces all over the world were reshuffled and redeployed in preparation for a possible Cuban invasion, a Soviet attack on Western Europe, or, perhaps, Armageddon. Some of them came from JTF-8, with aircraft and ships called away from the Pacific to reinforce preparations elsewhere. General Starbird was reassigned to Washington to head the Defense Communications Agency, which would soon set up the “hotline” link between Washington and Moscow in the wake of the crisis. As his deputy, Admiral Mustin became acting commander of JTF-8—once again the reluctant leader of a nuclear test series.

Despite international tensions at perhaps their highest level in history, the tests went on. It was probably in part due to simple inertia: the whole DOMINIC operation was simply too complex, too far-flung, and too far along already to shut down so abruptly for an indefinite period. But the saber-rattling element was also undoubtedly a factor. What better way to demonstrate one's resolve to an adversary than to detonate nuclear weapons?

So, on October 19, five days after the humiliating failure of Bluegill Double Prime, the next shot of Fishbowl was launched. Called Checkmate, it was a more modest effort all around, using a smaller XM-33 rocket instead of the massive Thor, and with a much smaller yield: less than 5 kilotons. It detonated successfully at an altitude of just over ninety miles, creating a lovely light show, though not of Starfish Prime proportions. Ogle described "a green and blue ring with spikelike protrusions at the edge, surrounded by a blood-red auroral ring which faded in less than a minute. Auroral streamers to the north and south formed immediately. Pink streamers were still visible 30 minutes after the explosion."[15]

Meanwhile, the USSR was following suit, having resumed their own high-altitude experiments. They fired off two high-altitude tests over the ensuing week, as if to match the US in saber-rattling belligerence and also to continue research on their own missile defense concepts. Although these tests were still smaller than Starfish Prime (around 300 kilotons), and at altitudes under two hunded miles, they created massive EMP effects over Russia, by design and in keeping with the scientific intent of investigating the military utility of EMP. In the midst of it all, the Cuban Missile Crisis was rapidly building to its climax. Whether that would mean a peaceful resolution or the end of civilization remained to be seen.

One way or another, it was not going to stop yet another try for Bluegill. Just before midnight on October 25, Bluegill Triple Prime was launched from Johnston Island—the fourth attempt for this particular test. To the enormous relief of all concerned, the Thor flew straight and true, and the 400-kiloton Bluegill Triple Prime warhead detonated at a relatively low thirty miles. But it was enough. The scientific experiments and photography all went well, and all three of the instrument pods were successfully ejected and recovered from the Thor booster. Notes the Defense Nuclear Agency history, "That was a good thing, for, as Air Force Chief of Staff General Curtis LeMay pointed out, there were no Thor missiles left in case any failed."[16]

There were, however, at least two casualties. After first being recognized as a danger in 1958, precautions against the eyeburn problem had become standard procedure for high-altitude operations. Test personnel were either issued eye protection or otherwise prevented from seeing the initial fireball, and a vast protected area was routinely established around the test location and kept clear of unauthorized civilian interlopers.

But that, of course, did not preclude accidents or simple misfortune. Two enlisted military men on Johnston Island, one Air Force and one Navy, were inadvertently caught without their protective goggles when Bluegill Triple Prime went off. Fortunately, neither was completely blinded, though both suffered eye damage.

Back in Washington and Moscow, Kennedy and Khrushchev had managed to step back from catastrophe over the Cuban crisis, partly through the auspices of their own better angels and partly through sheer luck. That did not change matters either in the Pacific or over the Soviet testing range. There were still bombs to test, experiments to be carried out.

But Fishbowl, at least, was finally approaching its long-delayed finale. On the evening of October 31, the last remaining Thor missile stood ready to launch the Kingfish device from Johnston Island. The weather and some last-minute technical problems delayed the proceedings until about 2 AM, but the launch and detonation of the 400-kiloton device at about sixty miles went off smoothly. Again, the central Pacific was treated to a light show of "a yellow-white, luminous circle with intense purple streamers."[17] Again, some EMP effects were recorded, but of very low intensity compared to Starfish Prime. Back on Johnston Island, "The rest of the night was spent in celebration."[18]

Two nights later, the ill-starred yet spectacular Fishbowl operation would draw down the curtain. Tightrope—planned as a test for the Nike-Hercules air defense missile—exploded its low-yield warhead at about thirteen miles above the earth, demonstrating the ability of the Nike-Hercules system to knock out an incoming Soviet missile, at least theoretically.

For all the long-frustrated, sorely frazzled Fishbowl personnel, their work was done. Fishbowl and DOMINIC itself were over. Some were not exactly happy at the prospect, such as dedicated Pentagon weapons scientist Frank Shelton. "After observing the success of Tightrope, Frank Shelton returned to his living quarters in a melancholy mood. ‘That was the 65th atmospheric nuclear weapon burst that I have observed in the past 10 years,’ he recalled saying to himself, ‘and I think it is probably the last one that I will ever see conducted in the atmosphere.’”[19]

Although it wasn’t at the time officially planned to hold the particular distinction, Tightrope would, in fact, be the final nuclear weapon exploded in the atmosphere by the United States, closing an era that had begun with the Trinity test on July 16, 1945. With the conclusion of DOMINIC, US nuclear testing would retreat to underground caverns and tunnels, mostly in southern Nevada.

But not without a struggle. The Pentagon and the weapons labs, perhaps sharing Shelton’s gloomy feelings, pressed for new nuclear tests in 1963 and beyond, and not just underground. For the time being at least, the Pacific testing facilities were only being shuttered, not completely abolished. As far as the AEC and the military were concerned, there remained new avenues to explore, new phenomena to test and observe, and perhaps new weapons and defenses to develop. As always, there was the fear that the Soviets were pulling ahead somehow, in ominous ways that would ultimately threaten the security of the United States.

But there could be a way to counter the new threats. First Teak and Orange, and then Nicholas Christofilos and Argus had opened new frontiers of tantalizing military potential. Fishbowl and especially Starfish Prime had confirmed and expanded that potential, inspiring and firing the imaginations of the planners of war and the builders of its tools. So even as Kennedy and Khrushchev, sobered by their recent brush with oblivion and newly anxious to find some way to reduce the danger, continued to move fitfully toward some kind of lasting reconciliation, others in the Pentagon and weapons laboratories were taking a deep and thoughtful look at new possibilities. If the politicians and diplomats were still talking—striving toward concord in Geneva, striving for test bans and treaties—the generals, admirals, and weaponeers were imagining and planning for what might happen if peace failed.

CHAPTER 17

The Fire of Damocles

EVER SINCE THE FISHBOWL TESTS HAD BEEN ANNOUNCED TO A WARY WORLD still reeling from the resumption of atmospheric nuclear testing, authorities from President Kennedy on down had been reassuring everyone that not only would the Van Allen belts remain unharmed from the atomic assault, but also that any fallout from the high-altitude shots would be nonexistent or negligible at best, taking years to drift down to ground level, by which time it would have decayed to safe levels anyway. Unlike the dirty, widely contaminating shots being fired off by the Russians, went the unspoken implication.

As the Cuban Missile Crisis passed into chilly memory and test-ban negotiations continued apace, those official reassurances began to feel less than reassuring. First, at the beginning of September, the Pentagon and AEC had issued a somber joint statement that the residual Starfish Prime radiation was stronger than predicted and might last for years, having already disabled three satellites. That statement had been vehemently disputed by James Van Allen, based on the data he had been collecting from the Injun 1 satellite. But he had noted that there might be some hazards to human space travelers passing through either the natural or Starfish-created radiation belts. The President's Science Advisory Committee (PSAC) backed the more alarmist assessments, despite protests from Van Allen that the public statements had been issued before the scientific evaluation of the satellite observations had been completely analyzed.

Then, in November 1962, Telstar began to have serious problems, and finally went dark altogether. The combination of Starfish Prime, some of the other Fishbowl tests, and the recently conducted Soviet high-altitude tests proved too much for its sensitive electronics to endure. Engineers did manage to coax the satellite back into operation briefly in January 1963, but it proved only a temporary reprieve, and the world's first telecommunications satellite went out of business permanently the following month.

Van Allen continued to criticize the government’s handling of the matter. Throughout the remainder of 1962 and into early 1963, speaking at various scientific conferences and meetings, he derided the administration’s statements as “hasty, ill-considered” and inaccurate. Said the *Washington Post*, “There is a growing body of expert opinion which holds that the artificial Van Allen radiation belt created by the [Starfish] blast is neither as intense nor as long-lived as was officially suggested by Defense Department and Atomic Energy Commission scientists in August.” Noting that such concerns had led to the substantial revision of the Fishbowl testing plans (though overlooking the various technical problems that had also played a part), the *Post* continued, “there appears to be growing evidence that those scientists who foresaw only a temporary and relatively slight enrichment of the natural belts were correct … whether these questions will be resolved to everyone’s satisfaction is debatable. The measurement and mapping of artificial radiation has become vastly complicated.”[1]

At the annual meeting of the American Association for the Advancement of Science in Philadelphia, Van Allen took his criticisms beyond the technical and into the realm of the political, directly challenging the PSAC, calling it a “vague and authoritative machine.” Van Allen told his colleagues that “the PSAC meetings at which I’ve been present have been exceedingly intimidating sessions … They are essentially governmentally dominated.” The PSAC, in effect, was little more than a body of “highhanded autocrats” who tended to disregard independent, non-government scientists in favor of hasty decisions and political expediency. Not only that, but “our failure as a nation to produce a substantial study of the scientific consequences of these tests long before the decision was made to conduct them and before an announcement was made that they were to be conducted, is, it seems to me, quite inexcusable.” It was, said Van Allen, a “shabby” episode all around. “Van Allen Sees Science ‘Clique’; Says Data on Radiation Belt Reflect Hasty Judgment By Government Insiders,” read Walter Sullivan’s *New York Times* headline.[2]

Such broadsides from America’s most prominent space scientist in such a high-visibility forum could not go unanswered, particularly when other scientists began to speak out in agreement, both on the specifics of Starfish and on the government’s scientific policies in general. Government scientists soon began to respond, claiming that instead of any nefarious intentions to “intimidate” or ignore their non-administration colleagues, the early, dire reports on Starfish Prime effects had been due to “piecemeal leaks” of initial data that considerably exaggerated the danger both to satellites and to human space travelers. More intriguing was the contention that the government’s reports had also been intended to give the Soviets some second thoughts about conducting their own high-altitude tests, perhaps convincing them that there might be some tempting propaganda value to calling off or limiting their own plans. It had not dissuaded the Russians at all, of course, but it was at least a plausible explanation given the realities of Cold War politics. Administration scientists also pointed out that not everyone agreed with Van Allen’s criticisms, and he had had ample opportunity to speak up publicly before the reports had been issued. Attempts to discover how he may have been actually “intimidated” yielded nothing.[3]

Obviously, it had all been a routine scientific controversy, mostly originating from the fact that Van Allen had been relying mostly on Injun 1 data while the government had trusted measurements mostly from Telstar. A few weeks later, however, the AEC, Pentagon, and NASA issued a joint report that officially revised their earlier estimates and stated that the Starfish belt would likely vanish within a few more months, or even weeks.

But the controversy was not quite laid to rest. By this time, more detailed and careful studies of the Starfish data had been conducted by all the various sources, and papers were beginning to appear in scientific journals. In March, Van Allen changed his mind, announcing that he now believed that the Starfish Prime radiation belt would persist for a least a decade, with an intensity that would substantially interfere with scientific studies of the natural belts. He explained that his earlier position had been based upon “intuitive” scientific expectations, but that the new mass of hard data now appearing from the various satellites had proven him wrong. To his immense credit as a scientist, he had followed the data, readily reversing his previously strongly held position when new facts made it necessary, with no fears of saving face or embarrassing himself. “It’s the difference between intuitive expectations and actual observations,” he remarked.[4]

Scientific disagreements were one thing, and of little concern to the military and defense establishment. Far more concerning to them was the fact that the Soviet Union had been conducting their own high-altitude tests—and that they also had satellites in orbit capable of observing and collecting data on the US tests. Two Kosmos satellites had been launched in the spring of 1962 and had been in excellent position to observe Starfish Prime that June. It was not lost on Pentagon officials that, just as the data collected by US satellites could be employed for both benign scientific discovery and darker military purposes, so could the observations of the Kosmos spacecraft. And if the United States was detonating nuclear weapons in space to investigate their military relevance, then the Soviet Union was undoubtedly doing the same thing.

The prospects for any resumption in atmospheric testing, much less Fishbowl-style high-altitude and outer space shots, had receded to near-impossibility as the test-ban talks proceeded and the US and USSR sought to ease tensions after the Cuban Missile Crisis. But Fishbowl, with both its successes and failures, had fired up new concepts. The goal of establishing an anti-ICBM defense system remained elusive. But a fresh arena of possible conflict had opened, a new frontier of offense and defense: satellites.

America was already operating its first attempts at a spy satellite system with the CORONA project, and undoubtedly the Soviets would soon be doing likewise. But there was another disturbing possibility: nuclear warheads not on missiles, but on orbiting satellites. Air Force intelligence experts worried that the Soviets could bypass the low accuracy and range of their existing missiles by simply lofting warheads into orbit—allowing them to be "de-orbited" and brought down at will on any target. All such a capability required were huge multimegaton warheads and the massive rocket power to put them into space, both of which the Russians had already amply demonstrated. A State Department report observed that "a thermonuclear 'sword of Damocles' would seem to hang over everyone's head in a way which, logic and military technology aside, ICBMs do not … in anticipation of the contingency of a Soviet weapon in space and recognizing that it may be necessary to undertake physical countermeasures, we should develop as rapidly as possible anti-satellite capabilities."[5]

Fishbowl had already demonstrated just how such a capability might work by exploding nuclear weapons at high altitudes, carried aloft by missiles. "The Starfish Prime test results showed that a high dose of radiation could provide the basis for an ASAT [anti-satellite] system," noted an Air Force historical study. Only two months after Starfish Prime, Major General Bernard Schriever, commander of the Air Force Ballistic Missile Division, proposed to Air Force Secretary Eugene Zuckert that the Thor launching facilities on Johnston Island could form the nucleus of an ASAT system. Secretary of Defense Robert McNamara approved further studies and development work on November 20. By February 1963, Program 437 would be going full speed ahead.[6]

In many ways, Program 437 was the logical culmination of Project Argus. Argus had demonstrated that Nicholas Christofilos's original concepts of a defensive shield against Russian missiles were intriguing but ultimately impractical, while suggesting tantalizing possibilities for further investigation. Fishbowl and especially Starfish Prime had shown the potential of these possibilities: not only for defense, but for offense. Slowly, steadily, the Argus idea had evolved from gathering plowshares into forging swords.

Program 437 was actually the second American ASAT system. Preceding and then overlapping it for a time was Program 505, an Army system based on its Nike-Zeus anti-ballistic missile (ABM).[7] The Nike-Zeus was the centerpiece of a bitter, complex interservice rivalry between the Army and the Air Force over the ABM mission throughout the late 1950s and early 1960s. Program 505 was the Army's bid to beat the Air Force at its own game. A Nike-Zeus ASAT battery based on Kwajalein Atoll in the Marshall Islands seemed promising in initial 1962 tests during Fishbowl, but pesky technical limitations persisted, including tracking and guidance problems, a relatively short effective range, and the inability of Nike-Zeus to carry anything other than a fairly small warhead (low "throw-weight," in missile jargon).

Program 505 would continue to drag on for several more years, but for the ASAT job, the Thor-based Program 437 seemed a better alternative, both to Secretary of Defense McNamara and, of course, to the Air Force. By the summer of 1963, President Kennedy himself declared it to be "in the highest national priority category for research and development."[8]

But research and development didn't necessarily translate to a fully operational and deployed system. An official meeting later that year chaired by McNamara showed that some in the administration had nagging doubts about both the practicality and advisability of Program 437. Noted an official Air Force history: "Most of the civilian leadership of both the State and Defense Departments were very nervous about even having a program of research and development for something like 437, let alone the prospect of having such a system operationally ready and manned by 'blue suiters' [i.e., Air Force personnel]. Certainly the aspect of detonating a nuclear weapon in space was politically unattractive to them.” Finally, journalist Edward R. Murrow, attending the meeting in his official capacity as director of the US Information Agency, calmly remarked: “If the Soviets place a bomb in orbit and threaten us and if this administration has refused to develop a capability to destroy it in orbit, you will see the first impeachment proceeding of an American President since Andrew Johnson.” That caused “about two minutes of total silence … Finally, McNamara said testily, ‘Well, it doesn’t cost much, and the JCS [Joint Chiefs of Staff] want it, so let’s approve 437.’”[9]

The Johnston Island launch complex that had hosted Fishbowl became the home of the newly established 10th Aerospace Defense Squadron (ADS) of the US Air Force, with a backup and support facility at Vandenberg Air Force Base in California. Beginning in 1964, tests and exercises began, all using non-nuclear-armed missiles, and the 10th ADS was declared fully operational by the middle of the year. For target practice, the crews used spent rocket stages and other space junk in orbit. Two Thor missiles would remain on twenty-four-hour alert at Johnston Island, with two kept in ready reserve at Vandenberg.

Yet it was unknown to the public at large. President Kennedy had occasionally commented on a US ASAT capability, but made no official announcements of its existence. In fall 1964, his successor, Lyndon Johnson, “during a reelection campaign trip to Sacramento, disclosed that the United States had developed an ASAT capability to intercept a satellite that might be carrying a weapon that threatened US national security.” The following day, McNamara announced it officially, without giving up much in the way of details. It was unclear whether Johnson’s announcement had been inadvertent or intentional, but “whatever his reasons … President Johnson not only put the Soviets on warning that the United States had an operational ASAT system, but he also told the electorate that he was prepared to defend the country from any possible attack, even if it came from outer space.”[10] No doubt Johnson’s proclamation didn’t hurt his landslide election victory two months later.

It may have been comforting to both the public and the Pentagon to know that Program 437 existed, but in reality it was far from perfect. As defense funding began to be increasingly siphoned away by the steadily growing demands of the Vietnam War, the Air Force found it difficult to keep paying for the Thor missiles needed for test launches and operational proficiency maintenance for the 10th ADS crews. Also, the single location at Johnston Island didn’t permit global coverage; the Soviets could conceivably avoid the Program 437 defenses altogether by choosing different launch and orbital profiles for their satellites. Another practical military consideration was that, tactically speaking, Johnston Island was hardly a stronghold, and could easily have been overwhelmed by a commando raid aimed at destroying the missiles and launch pads. Air Force commanders were quite aware that Soviet submarines routinely parked in international waters near Johnston Island to observe test launches. Any conceivable support forces against an attack were hundreds of miles away on Hawaii. Mother Nature posed another threat: “A more likely source of damage to Program 437 was from strong tropical storms that potentially could batter the island and reduce the site to rubble.”[11]

Perhaps the biggest problem of all harkened back to Program 437’s nuclear roots in Argus and Starfish. The effects of a nuclear explosion in space had no respect for national boundaries. Attacking another country’s satellite with a nuclear weapon—even if it was an orbiting warhead and not merely an innocuous weather satellite—could quite naturally be interpreted as the opening of an all-out nuclear strike, sparking general war. Even under the best circumstances, the EMP and radiation effects of a Program 437 strike could quite likely cripple or destroy friendly satellites, as Starfish Prime had so clearly demonstrated.

The supposed threat of orbiting Soviet nukes never materialized, and as funding continued to diminish, Program 437 slowly faded into oblivion. Attempts to keep it alive by altering or enhancing its original ASAT mission proved abortive, while the Pacific Ocean took its toll. “The Thor boosters stood alert on open launch pads, unprotected from the harsh environment and strong Pacific storms or other natural disasters. Over time the rocket bodies and launch support equipment were susceptible to the corrosive effects of the heat, humidity, and salt-water spray.”[12] Launch equipment began to fail. By 1970 the Air Force began to shut down operations. Then, in August 1972, a hurricane passed close to Johnston Island, severely damaging the launch pads and other facilities and speeding the program’s demise, which finally became official in 1975. The notion of antisatellite weapons persisted, however, taking different and sometimes outlandish forms, such as the use of F-15 fighter planes to launch ASATs from high altitude, a sequel to the Navy's old NOTSNIK idea.

Program 437 would not be the end of further talk of using nuclear weapons in space, however. Several years later, the grandiose schemes of Ronald Reagan's Strategic Defense Initiative, more commonly known as "Star Wars," would propose orbiting X-ray lasers powered by hydrogen bombs and other similarly apocalyptic devices as defensive countermeasures to enemy ICBMs. The electromagnetic pulse effects that had been first revealed by Teak, Orange, Starfish Prime, and even Argus were not forgotten either by SDI planners or by the military officials, scientists, and political strategists who followed them.

Some ideas, it seems, refuse to go away. As the more immediate descendants of Argus and Starfish such as Program 437 fizzled out and passed into historical obscurity in the years that followed, the original dreams of Nicholas Christofilos would continue to mutate into a dark specter, a shadow that persists into the twenty-first century and beyond.

ON MONDAY, JUNE 10, 1963, PRESIDENT JOHN F. KENNEDY DELIVERED WHAT would be one of the most influential and important speeches of his brief presidency, a commencement address at the American University in Washington, D.C. He and his speechwriter Theodore Sorensen had titled it "A Strategy of Peace," but it would soon become better known as JFK's American University speech, or more simply, his "peace speech."

With all the Cold War crises and tensions that had haunted his presidency, and the nightmarish days of the Cuban Missile Crisis still fresh in his mind, Kennedy was anxious to set out on a new course, a more hopeful path to the future than the nuclear oblivion that, so often, had seemed inevitable. He spoke of world peace, "the kind of peace that makes life on earth worth living … not merely peace for Americans but peace for all men and women, not merely peace in our time but peace in all time."

Too many, Kennedy said, "think it is impossible. Too many think it is unreal. But that is a dangerous, defeatist belief. It leads to the conclusion that war is inevitable, that mankind is doomed, that we are gripped by forces we cannot control. We need not accept that view. Our problems are manmade; therefore, they can be solved by man."

Kennedy went beyond such stirring rhetoric, however, to make concrete and practical proposals. Our attitudes toward the Soviet Union had to be reexamined. In the event of war, he noted, “our two countries would become the primary targets … all we have built, all we have worked for, would be destroyed in the first twenty-four hours.”

To forestall that catastrophe, the president called for early agreement on a comprehensive nuclear test ban treaty, while also pledging that the United States “does not propose to conduct nuclear tests in the atmosphere so long as other states do not do so. We will not be the first to resume.” He observed that while “such a declaration is no substitute for a formal binding treaty” or “a substitute for disarmament,” he hoped it would help achieve both goals.

The speech stands as one of the most remarkable statements ever made by an American president, not only in historical hindsight but especially considering the time in which it was delivered. And it would have an immediate impact, most importantly upon Nikita Khrushchev, who found Kennedy’s words profoundly inspiring and encouraging. Less than a month after the speech, Khrushchev proposed a partial nuclear test ban treaty, barring all but underground tests. Several weeks later, a formal treaty was signed by the US, USSR, and Great Britain. The Partial or Limited Test Ban Treaty, more formally designated as the Treaty Banning Nuclear Tests in the Atmosphere, in Outer Space and Under Water, was soon ratified by the US Senate and signed into law by Kennedy on October 7, 1963. It went into effect three days later.

After years of temporary moratoriums, diplomatic wrangling, military planning, successful and completely botched test operations, radioactive fallout and mushroom clouds and fireballs brighter and hotter than the sun, the days of open nuclear testing were over. At least for the United States, Soviet Union, and United Kingdom. Other nations such as China and France would soon conduct their own atmospheric tests, quite unconcerned with any agreements concluded by their more powerful international rivals.

But since the Tightrope shot that concluded Operation Fishbowl in 1962, no nuclear explosions have yet taken place in or near outer space.

There are, however, no guarantees.

CHAPTER 18

Threats and Legacies

ONE DAY IN JUNE, 1999, REPRESENTATIVE ROSCOE BARTLETT (R-MARYLAND) SAT in a Vienna hotel room along with ten of his colleagues and some congressional staffers, facing three members of the Russian Duma and a representative of Serbian president Slobodan Milosevic. The group had been busy hammering out a framework agreement to end the bloody war in Kosovo.

Tensions were high and tempers short, with the Russians feeling slighted that they had been brought into the negotiations on an almost after-the-fact basis by the United States and NATO powers. As Bartlett later recalled, the dominant member of the Russian group, former ambassador to the US and deputy Duma chairman Vladimir Lukin, "was very angry and sat with his arms crossed looking at the ceiling for a couple of days during these discussions." Lukin was visibly offended by what he perceived as an American snub, complaining that "you spit on us, now why should we help you?"

Finally, Lukin made an offhand remark that stunned the leader of the American delegation, Curt Weldon, who spoke Russian. "Did you hear what he said?" Weldon asked Bartlett, before the translator repeated it in English.

Bartlett, who spoke no Russian, shook his head. Then the translator gave them Lukin's words: "If we really wanted to hurt you, with no fear of retaliation, we would launch an SLBM [submarine-launched ballistic missile] from the ocean, detonate a nuclear weapon high above your country, and shut down your power grid and your communications for six months or so." As if to emphasize the point, a younger member of the Russian group added, "And if one weapon wouldn't do it, we have some spares."[1]

It was a remarkable threat, chilling in its implications, plain in character, and entirely plausible. The Russians were talking about an EMP weapon—essentially a scaled-up version of Argus, Starfish Prime, or Teak, specifically designed to generate an intense electromagnetic pulse effect when detonated at high altitude.

It was a threat unlike the blustery Cold War boasts of Nikita Khrushchev—his “we will bury you,” or when he pounded his fists on his desk at the United Nations. At the time, as exercised as some Western leaders and strategists allowed themselves to become in response to such statements, some fundamental understanding remained that in the end, it was all talk, all sound and fury signifying very little, if not nothing.

But this was different. This was an unguarded, ill-advised remark made by a frustrated and exhausted man who would probably have never said such a thing under better circumstances. It was certainly not an official statement of Russian policy that required a decisive US response.

Yet it was its very casualness that gave it such impact. Aside from being a congressman, Bartlett was also a scientist, specifically a physiologist, and a former director of the Space Life Sciences Group at the Applied Physics Laboratory of Johns Hopkins University, working on NASA contracts. He also served on the House Armed Services Committee and the Committee on Science, Space, and Technology. The phenomenon of EMP was certainly not new to him. But until this moment, he had never really thought through its ultimate meaning.

Soon after, the Kosovo negotiations successfully ended with an agreement adopted by the G-8 nations, and the Russian and American delegations went home. But Bartlett continued to be haunted by Lukin’s words. He became a major force in calling for hearings on the EMP threat, which led to the formal establishment of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack.

In a 2004 report, the Commission noted that while “EMP effects from nuclear bursts are not new threats to our nation,” they previously would have likely occurred as a consequences of general nuclear war, when their impact would pale in comparison to the wholesale obliteration of cities and populations. Defense against EMP meant deterring nuclear war, period. But now, the threat can come from “terrorist groups that have no state identity, have only one or a few weapons, and are motivated to attack the US without regard for their own safety.”[2]

The Commission also noted that the threat didn’t merely encompass an attack on obvious vital US infrastructure targets such as the power grid. Other government agencies, including the Pentagon’s Defense Threat Reduction Agency, conducted their own studies and issued their own reports, pointing out that EMP can also be used as an antisatellite weapon, as Starfish Prime had demonstrated back in 1962.

Since Argus and Starfish Prime, the United States and much of the rest of the world have come to depend on a robust and extensive infrastructure of satellites and communication networks. Losing them would affect far more than our economies and cultures. Satellites are indispensable for modern military forces—particularly those of the US. They are involved in intelligence collection, strategic planning, and tactical operations of all kinds. And that indispensability has made us more vulnerable than ever before.

Even a relatively small nuclear warhead, sent aloft by a small rocket to a humble altitude of as low as sixty miles, could cripple or destroy many vital satellites. It's technology that's within the reach of many countries, including North Korea, Iran, India, Pakistan—nations not as dependent upon space resources as more advanced nations, and thus less likely to feel their loss. It's perhaps one of the most underappreciated threats we face today. Just as a band of terrorists managed to shock the world with hijacked airliners and a few box cutters, any country or group with access to nuclear weapons and 1950s-era launch technology has the potential to bring twenty-first-century Western civilization to its knees.

After a long career in Congress that began in 1982, Roscoe Bartlett finally became a private citizen after losing a reelection bid in the 2012 midterms. Aside from being one of the longest-serving members of the House, he's now famous for retreating to a distant mountain cabin in West Virginia to live completely off the grid, with no outside electricity, plumbing, or phone service. Instead of retiring to plush luxury in the usual tradition of career politicians, Bartlett lives with solar panels, wood-burning stoves, and composting toilets. Still active as a private consultant, he continues to crusade for measures to protect the US infrastructure from EMP, solar storms, and cyberattack, whether from natural origins or terrorist action. He is confident that he and his family are prepared for catastrophe. He still worries that the United States is not.

The congressional EMP commission that Bartlett helped to establish offered some words of hope: "The Nation's vulnerability to EMP that gives rise to potentially large-scale, long-term consequences can be reasonably and readily reduced below the level of a potentially catastrophic national problem by coordinated and focused effort between the private and public sectors of our country," its members wrote. "Such actions are both rational and feasible."

More than a decade after that report, however, little if anything has been done. Tucked away on a remote mountain, Roscoe Bartlett remains frustrated that despite all the talk, all the commissions and studies and congressional testimony, and long after an annoyed Russian diplomat made an offhand remark in a Vienna hotel room, no definitive steps have been taken to address what he sees as an existential threat to Western civilization.

AFTER STARFISH PRIME AND HIS INJUN 1 SATELLITE, JAMES VAN ALLEN WAS FINISHED dealing with nuclear weapons. Even had he desired to continue any such involvement, the Partial Nuclear Test Ban Treaty and the subsequent Outer Space Treaty in 1967 essentially ensured that the only nuclear technologies that would henceforth be used in space would be wholly peaceful in nature. With the days of exoatmospheric nuclear testing over, the only radiation in space would be generated either by natural sources or by small devices generating power for deep space probes and Mars landers.

With one notable exception. The Starfish Prime radiation belt would continue to persist at a detectable level into the 1970s, and would indeed complicate scientific observations of the natural Van Allen belts and other solar and exoatmospheric phenomena. In the end, Van Allen had been proved right in discounting his scientific intuition and trusting the hard data that his instruments provided.

He would continue his distinguished career as America's premier space scientist, extending his explorations past Earth's orbital neighborhood to the outer reaches of the Solar System and beyond into interstellar space. Based at the University of Iowa[3] for the rest of his life, Van Allen built instruments for almost all the major space probe missions of the 1960s and 1970s, including the Mariner spacecraft that went to Venus and Mars and Pioneer 10 and 11, the first probes that ventured beyond the asteroid belt to Jupiter and Saturn and ultimately left the Solar System entirely. He would teach and mentor legions of undergraduate and graduate students, many of whom, such as George Ludwig and Carl McIlwain, would go on to distinguished scientific careers and achievements in their own right. Even after stepping down in 1985 as head of the Department of Physics and Astronomy at the University of Iowa, he continued to work tirelessly as an emeritus professor, showing up bright and early every morning at the Iowa City campus building where he had spent most of his career, the building which now bore his name.

He died in 2006 at the age of ninety-one.

Van Allen's place in the history of physics and space exploration is unassailable. He did, after all, make the first true scientific discovery of the space age—the first step for transforming space travel from a nationalistic stunt into a serious human endeavor. Yet some historians view his career with a somewhat jaundiced eye, questioning the close, often inextricable relationship with the military that characterized and enabled so much of his work.

Van Allen, of course, never denied or tried to hide that connection, and readily acknowledged that he had been conducting military-related research since his days as a Navy officer in World War II. But until Argus, he had never worked with nuclear weapons, a fact that entails a new level of ethical consideration. He was never directly involved in designing and building nuclear weapons, like so many of his fellow physicists. But in a real sense, he used them to conduct and benefit his own research. Where, some have asked, should he have drawn the line?

To some degree, Van Allen had no real choice. Especially during the years of the Cold War, the tools of his trade, including rockets and high-altitude balloons, were almost exclusively under the control of the military, so any scientist who needed to use them had to deal with military authorities. But some argue that perhaps Van Allen went too far. "By participating in a project to detonate bombs in outer space aimed at disrupting and militarizing the magnetosphere, he was behaving quintessentially as a product of the mid-twentieth-century cold war," wrote historian James Rodger Fleming. Referring to the effects of Starfish Prime, Fleming argues that "his actions, admittedly miscalculations, rendered the scientific study of a newly discovered planetary feature difficult if not impossible for over a decade."[4]

That seems an unfair criticism; after all, Van Allen had nothing directly to do with the planning or execution of Starfish Prime, nor of Argus or any of the other high-altitude shots. While it could be argued that he might have used his status and prestige to protest against them more vigorously, ultimately he had no power to stop such tests. But he also didn't hesitate to take advantage of them as a scientist. "He wrote about the science of it all, but he eagerly participated in the military aspects as well," Fleming said.[5]

Unlike some of his other colleagues, Van Allen could hardly be characterized as a militaristic Dr. Strangelove type. Rather, he may have been something of an innocuous opportunist. Historian Lisa Mundey cites a 1981 oral history interview with Van Allen in which he explained, “I didn’t really know much about the bomb business. I thought, if they were going to make a test, [space] was a good place to make one, as far as absence of fallout goes and adverse effects.”[6] Pointing out that Van Allen also fought for openness and making the results of Argus and the other tests public, Mundey concludes that “like many scientists of the era, he bought into the Cold War competition with the Soviets and engaged in defense-related research. His behavior after the public revelation of the [Argus] experiment, however, suggests that he wanted public credit for his achievements and so supported declassification.”[7]

Whether James Van Allen willingly compromised himself as a scientist by co-opting his work to the military or was merely doing whatever he had to do out of dedication to his profession is too complex a question to be ultimately resolved. As nuclear historian Alex Wellerstein points out, “Very little in good history boils down to easy ideological stances.” But James Van Allen’s connections with Argus and the other space nuclear tests—activities that were the first human attempts to intentionally alter the environment on a global scale—remain an inescapable part of his larger legacy. As Fleming observed, for better or worse, “his halo now has a decidedly nuclear glow.”[8]

FOR NICHOLAS CHRISTOFILOS, ETHICAL OR MORAL QUESTIONS ABOUT WHETHER or not a scientist had any business being involved with the military were a non-issue, nothing more than a foolish distraction. Following Argus and the subsequent analyses of the data, he returned to his pet project: the Astron accelerator at Livermore Lab.

Some people already considered Astron outlandish enough, but that didn’t stop Christofilos from continuing to generate other wild ideas, always with the same manic enthusiasm and persuasiveness. When he realized that Argus would not work as the impenetrable barrier to Russian missiles he had originally envisioned in his dreams, he refused to be discouraged. He simply moved on to other possibilities. “His ideas were grandiose and bizarre,” historian Sharon Weinberger wrote, “but usually so genius that they dazzled the physicists around him. What seemed to attract scientists was that the ideas themselves were scientifically sound but required technological miracles to make them work.”[9]

One of them was called Seesaw, a scheme for a massive particle beam weapon to knock down incoming Soviet ICBMs. It was just the sort of notion that would have fit in perfectly with the "Star Wars" schemes of the 1980s, except that Christofilos first proposed it in 1958. With the trademark Christofilos touch, nothing about Seesaw was modest or conservative. The weapon would have required massive amounts of energy, far more than any conceivable power source could provide. Conceivable, that is, to anyone but Christofilos. At one point, he proposed detonating hydrogen bombs to drain the Great Lakes, generating the necessary electrical power by using the resulting massive deluge of (radioactive) water. (He did at least recognize that such a measure would only be considered in an absolutely last-ditch scenario, such as when the US was already under massive attack.) Colleagues did the math and concluded that, absurd and unthinkable as it was, the idea would actually work—provided one accepted the immolation of the entire Midwest, of course. As Weinberger notes, "Christofilos's imagination was not tethered to practicality."[10] As an indication of the bizarre desperation driving the Cold War, Seesaw continued to be seriously studied and considered, if only theoretically, for decades after Christofilos first proposed it.

Not all of Christofilos's ideas were quite so apocalyptic. His Project Sanguine—a system for generating extremely low-frequency (ELF) radio waves using immense antennas buried deep underground to enable secret communication with submerged submarines all over the world—didn't involve setting off nuclear weapons. The underground basing would supposedly render the system invulnerable, ensuring that America's nuclear-armed submarine force would always be able to respond to a Soviet attack. The problem was the ELF antennas. Unlike conventional radio and TV signals, which range from millimeters to yards in wavelength, ELF waves are miles long, which means that the antennas must also be likewise. Christofilos's ideas involved even longer ELF waves that would actually be transmitted using natural ground electrical currents and the ionosphere.

But burying such a system underground would entail digging up thousands of square miles and causing extreme environmental disruption. When the Navy's plans to build a Sanguine site settled on northern Wisconsin, environmentalists and the public rebelled. "Isn't it about time that we refused to be brainwashed as to the necessity of bigger and more terrible things in the name of peace?” asked one letter to the *Chicago Tribune*.[11] Though experimental tests proved that the concept actually worked, Christofilos’s original Sanguine plans, conceived with his typical grand panache, were doomed. For years, however, the Navy employed a smaller-scale ELF system for submarine communications that used some of Christofilos’s ideas.

And there was always Astron. It had been his passion for particle accelerators that had first brought him to the United States and landed him his position at Livermore, and had burned continuously throughout his life. Its basic concept of using relativistic electrons to generate magnetic fields and contain plasma for fusion power had driven most of his other work, beginning with Argus.

Yet definitive success with Astron continued to elude him, despite years of experimentation, bureaucratic wrangling over funding, and controversy over the direction of the project. Christofilos achieved interesting results and intriguing insights, but never the grail of practical, controllable thermonuclear fusion. “No matter how tightly Christofilos clung to Astron’s reins, he could not force the electrons, or the resistors, or the pulser, or any other part of his apparatus, to behave as he wished,” observed a history of the project.[12] Yet his stubbornness impelled him to keep working, keep pushing. When Astron was dismissed as a “dark horse” in the quest for fusion power, Christofilos responded, “No, it is just a white horse, standing in the shadows.”[13]

By the beginning of the 1970s, the Astron project was struggling to survive; Christofilos was under ever greater demands for concrete results while under ever stricter deadlines imposed by the AEC. Always a workaholic, Christofilos was driving himself and his assistants through twelve-hour days, punctuated only occasionally by after-hours drinking bouts at local bars.

His personal life was no source of solace either. After his messy divorce from his first wife, his second marriage also ended in divorce. His sons, one from each of his wives, lived with their mothers. Christofilos was essentially alone, with only his ideas, his work, and the elusive dream of Astron. His health deteriorated, his visions clouding over.

By the fall of September 1972, it all caught up with him. After a meeting with AEC chairman James Schlesinger at Livermore, Christofilos checked into the local Holiday Inn, a practice he’d adopted to avoid a long commute home to Berkeley on late nights. The next morning, September 25, his secretary went in search of him when he failed to appear at the lab on his usual bright and early schedule, and found him in his room, dead of a massive heart attack. He was only fifty-six years old. The Astron project joined him in oblivion the following June, officially and permanently cancelled.

The “crazy Greek” was gone, finally overwhelmed by the passion of his ideas and relentless strivings. Though some of the various press obituaries that followed mentioned Argus in passing, it was Christofilos’s thermonuclear work with Astron that got the most attention, ensuring that he would be remembered as an inventive, original thinker, not as a weaponeer or military scientist.

For an individual such as Nicholas Christofilos, who lived his life and conducted his work with an unapologetic, uncompromising spirit, it was appropriate that his final legacy should be based on his strongest and most long-lasting passion. As a friend once described him: “For Nick, all pieces are written fortissimo.”

But some of his darker and more apocalyptic visions—Argus and the power and fury of nuclear weapons extending from the surface of Earth into the heavens and beyond—also survive. Thus far, those visions are still only the “crazy ideas” of a uniquely imaginative scientist. We can only continue to hope that they become nothing more.

Postscript:
A Persistent Afterglow

IN THE TWENTY-FIRST CENTURY, IT SEEMS INCREDIBLE THAT SOMETHING SUCH AS Argus or Fishbowl could have ever been contemplated, much less actually carried out. Surely such an enterprise, one nation deciding to conduct experiments that could conceivably affect the entire planet in unknown and perhaps dangerous ways, without the knowledge or consent of the rest of the world, was nothing less than the height of arrogance and hubris.

From the perspective of the Cold War era, when both the US and USSR were gripped by a more or less constant state of existential dread and when almost every move by the other side seemed to herald the path to doomsday, it's perhaps somewhat more understandable. A desperate struggle for survival can make the irrational seem rational, the terrible risk worth taking, the mad scheme seem reasonable. In such a climate, far removed from the context of a humane and peaceful culture, even Dr. Strangelove becomes a paragon of rationality.

Coupled with that sort of paranoid recklessness born of fear was also a certain naive ignorance. In the 1950s and 1960s, nuclear weapons were still a relatively new technology, and much about their capabilities remained uncertain or completely unknown. The first edition of *The Effects of Atomic Weapons*, a one-volume summary of the current state of knowledge about the atomic bomb published jointly by the Atomic Energy Commission and Department of Defense in 1950, contained absolutely no mention of the electromagnetic pulse phenomenon or the effects of high-altitude detonations, simply because they had not yet been observed in the relative handful of atomic blasts that had so far occurred. It wasn't until the third edition of the book (by then retitled *The Effects of Nuclear Weapons*), published in 1977, that detailed descriptions of EMP and high-altitude and outer space nuclear weapons phenomena could be included, after Argus and Fishbowl had provided the data.

Also, any thought that human beings could seriously do anything to profoundly affect the entire Earth at a single stroke seemed absurd, the stuff of science fiction rather than science. At the time of Argus and Fishbowl, climate science was in its infancy, and the concept of the Earth as a single, unified system of interrelated parts was even more remote. James Van Allen's discovery of the radiation belts, along with other geophysical research during the IGY, had begun to hint at such a perspective, but it would be years before it became common scientific or cultural coin.

So it may be comforting to think of Argus, Fishbowl, and the various Soviet nuclear space tests as historical anomalies, relics of their peculiar era, something that could never again be an issue. Even Herbert York, who had been one of the chief architects of Argus, seemed to hold this view. Many years afterward, he remarked: "Imagine proposing such a thing today. You'd never get away with it. But in that moment, you could."[1]

But consider the historical sequence of events. Argus was hastily conceived, organized, and executed in perhaps the most absolute secrecy attainable at the time, and would have quite possibly have remained classified to this day, but for the efforts of some enterprising journalists and scientists who finally forced its revelation. Once it went public, the very idea of Argus shocked and outraged many people, even some of the fiercest Cold Warriors. Yet a mere four years later, tourists threw parties on Hawaiian beaches to watch the light show produced by weapons that were orders of magnitude more powerful than the Argus shots exploded in outer space. Some people still protested, but for most of the public, Operation Fishbowl was merely a visual extravaganza, produced by their government with their tax dollars.

By the time of Fishbowl, the idea that humans might actually possess the power to affect and alter the entire planet had become a faint glimmer in the public perception, though still far dimmer and subtler than the brilliant displays of auroral fire from Fishbowl's tests. Ironically, the example of Argus and Fishbowl were one reason for this growing perception, inspiring many to worry about disrupting or destroying the Earth's natural radiation belts, climate, or even the tilt of its axis. And the tests now provide a powerful counterargument to those who, at a time when human beings are being forced to confront the long-term effects of their civilization upon the Earth's continued habitability, still argue that our activities can't possibly affect our planetary environment.

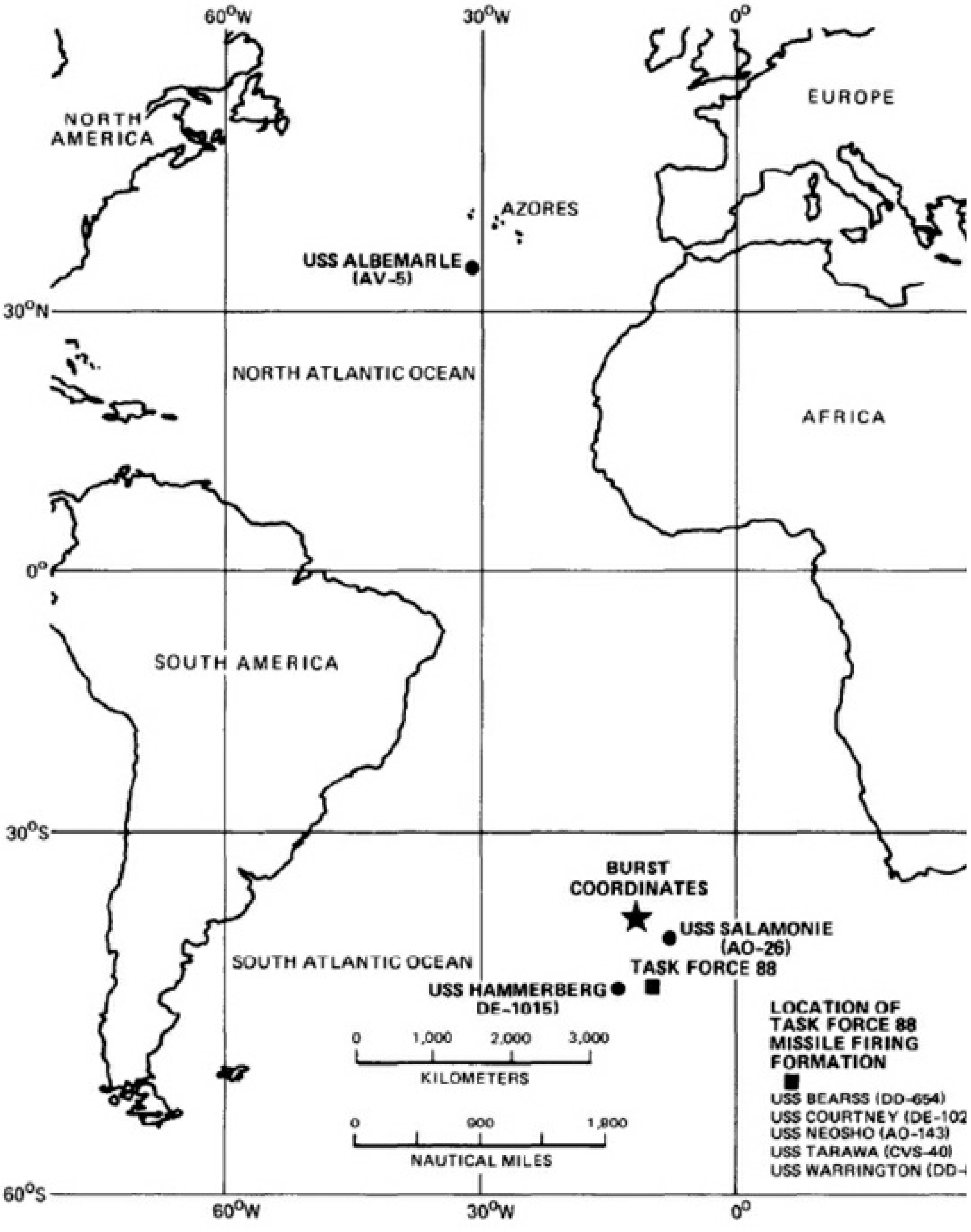
But the transition of nuclear weapons from the surface and near-surface of the Earth to outer space, the shift of their targeting from cities and military bases to a hemispheric and global scale, was perhaps even more alarming. By simply introducing it to a completely new environment, the most physically destructive weapon ever invented was found capable of wreaking devastation in entirely new ways that its creators had never contemplated. Now, argued some strategists, space-based nuclear weapons could destroy without killing and attack an enemy's vital interests without dropping a single warhead on its territory. The EMP and antisatellite capabilities of nuclear weapons offered an enhanced military versatility that made the consideration of their use in various scenarios seem more tempting, reasonable, and even humane. And the path was cleared to a brand new potential arena of warfare that could engulf and threaten the entire planet.

Fortunately, with the Limited Test Ban Treaty and the Outer Space Treaty, the international community chose to turn away from such a dangerous potential future, no doubt partly influenced by the brief preview that Argus and Fishbowl had provided. But the dreams of nuclear-based military space dominance persist, and have only been encouraged by our ever-increasing dependence on a satellite-based infrastructure, and the challenges posed by the growing space capabilities of rival nations.

Keeping the reaches of space a completely sacrosanct civilian refuge, free of any military presence, was never a realistic possibility. "The militarization of space has proceeded steadily and inexorably since the launch of Sputnik in 1957," wrote Stimson Center co-founder Michael Krepon in a 2003 report on military space policy. But Krepon and his co-author Christopher Clary also emphasize that while a military presence in space is a fact of life, "the crucial distinction between the militarization and weaponization of space remains in place."[2]

At present, that distinction still holds, but is becoming ever more tenuous. If we allow it to dissolve whether through casual indifference or conscious intention, the sky may yet again burn with nuclear fire.

Maps


60°W
30°W
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NORTH AMERICA
EUROPE
AZORES
USS ALBEMARLE (AV-5)
30°N
NORTH ATLANTIC OCEAN
AFRICA
0°
SOUTH AMERICA
30°S
BURST COORDINATES
USS SALAMONIE (AO-26)
TASK FORCE 88
SOUTH ATLANTIC OCEAN
USS HAMMERBERG DE-1015)
LOCATION OF TASK FORCE 88 MISSILE FIRING FORMATION
USS BEARSS (DD-654)
USS COURTNEY (DE-102
USS NEOSHO (AO-143)
USS TARAWA (CVS-40)
USS WARRINGTON (DD-
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KILOMETERS
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NAUTICAL MILES
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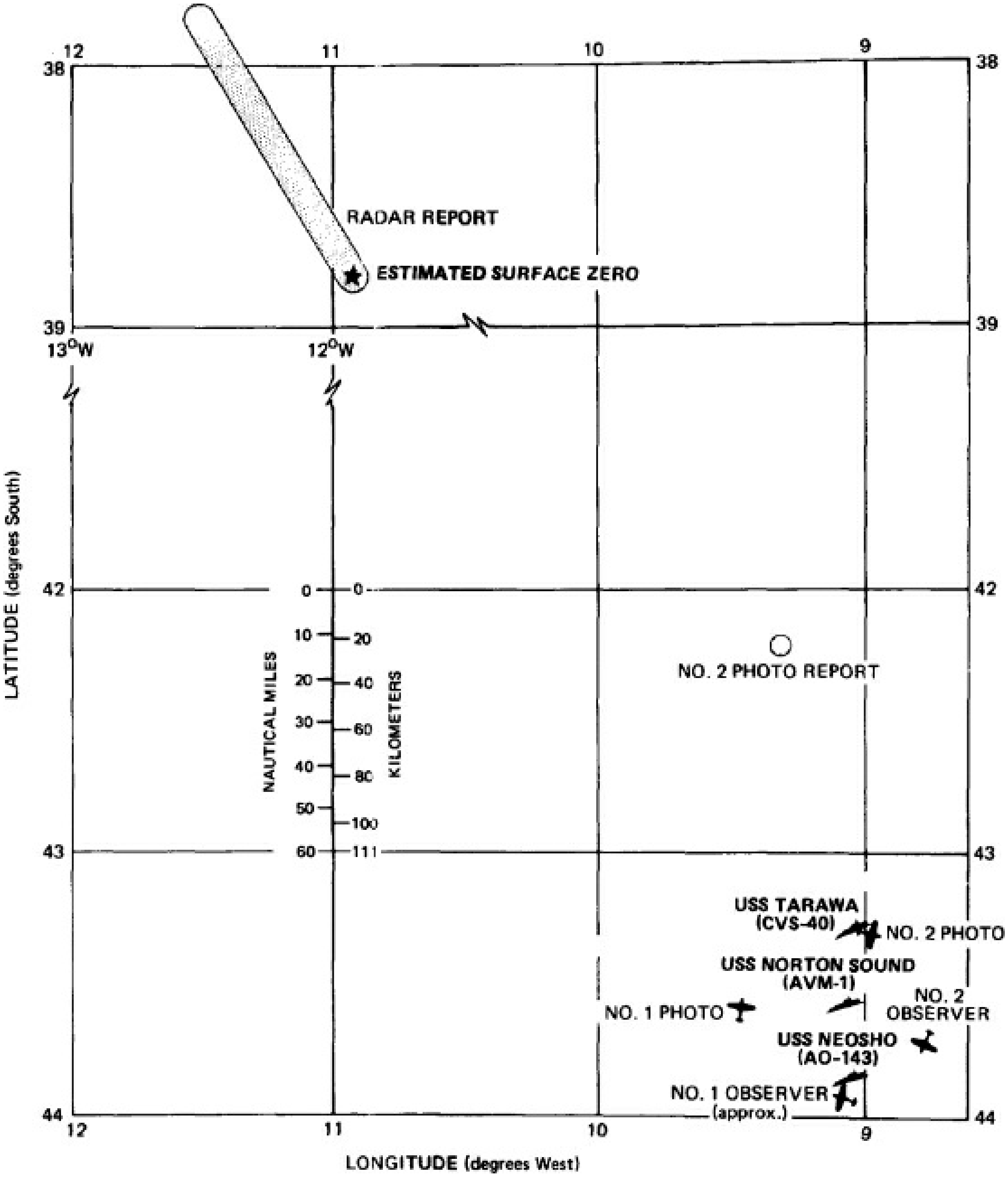
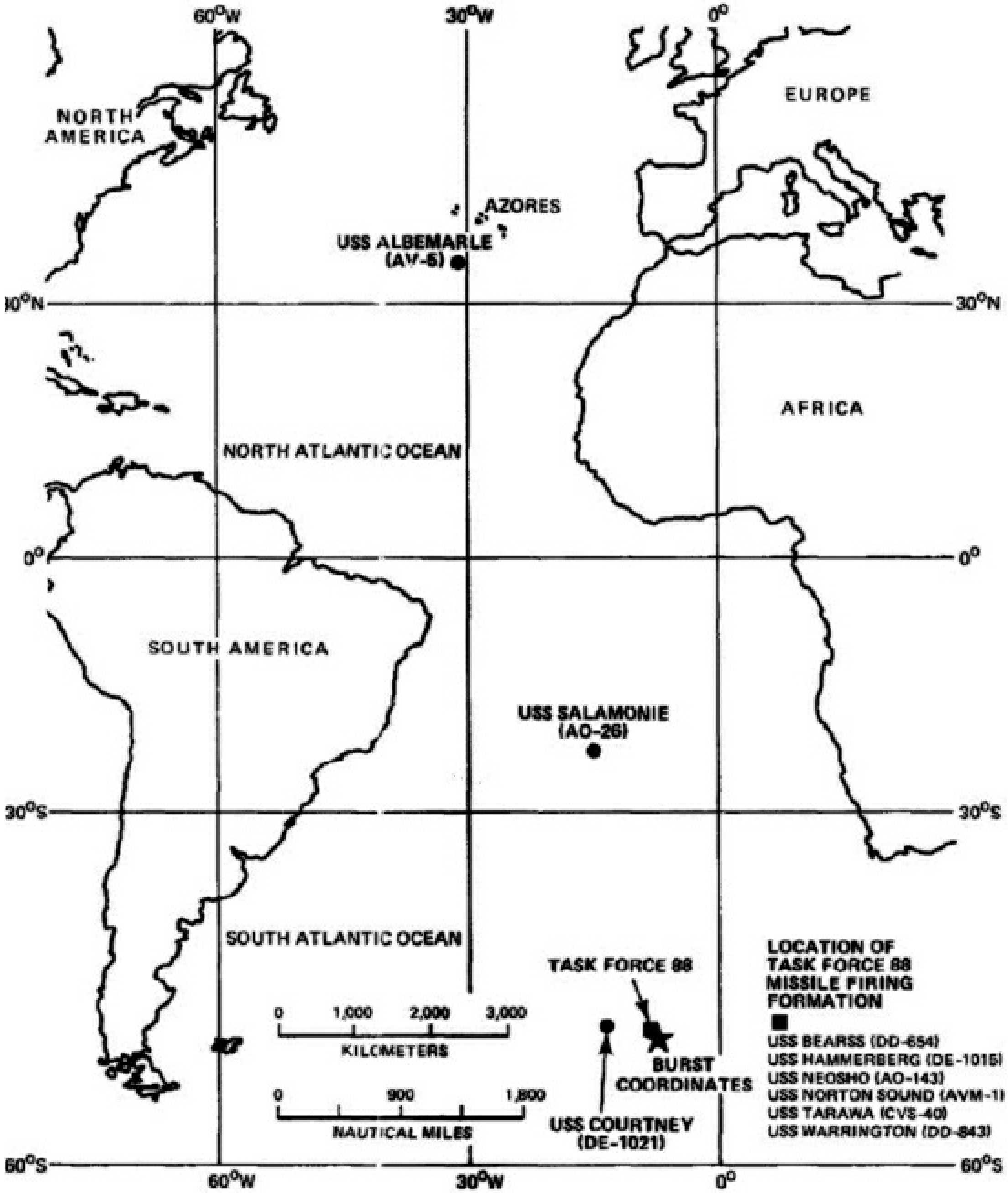
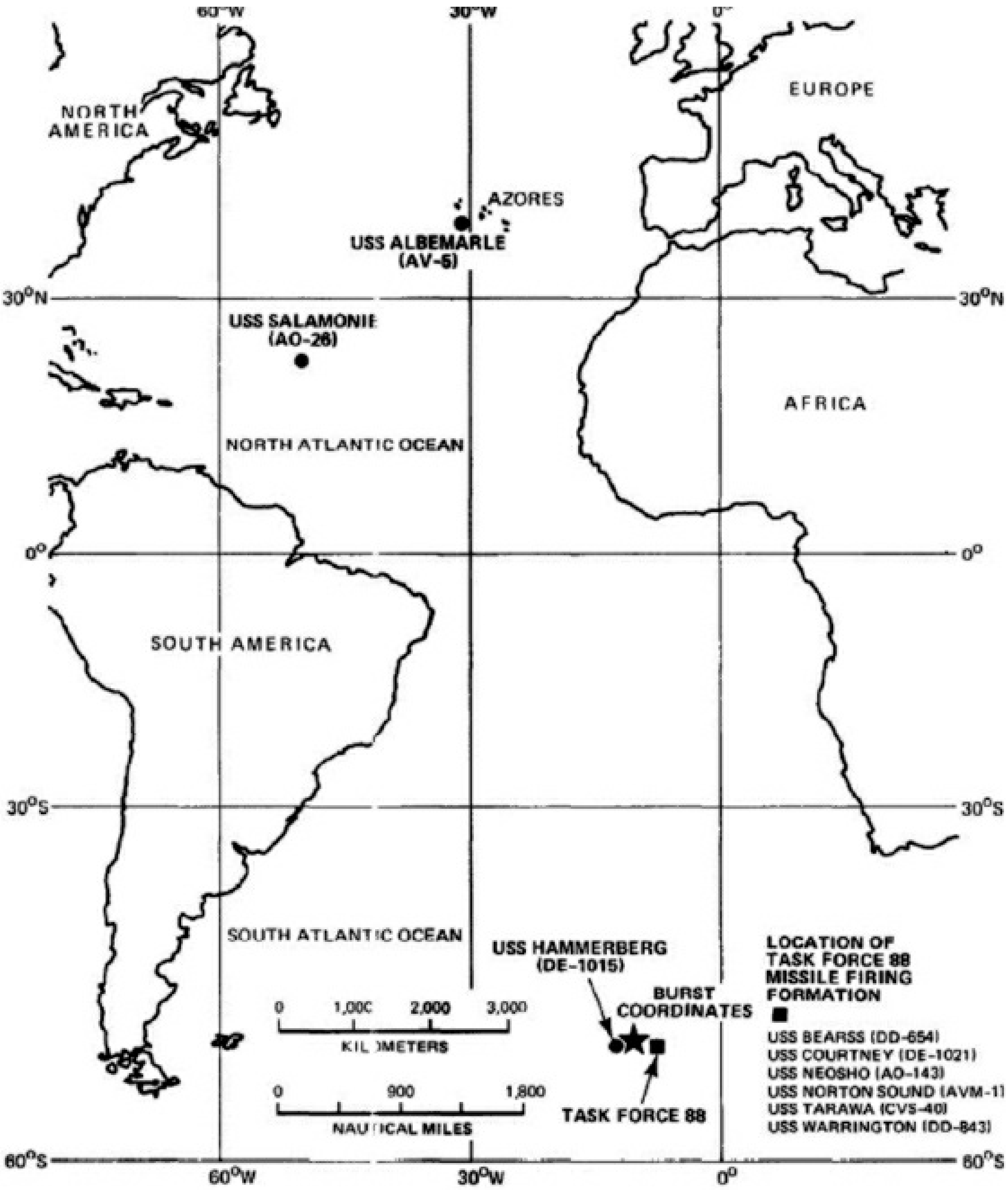
ARGUS 1, locations of ships at burst time.



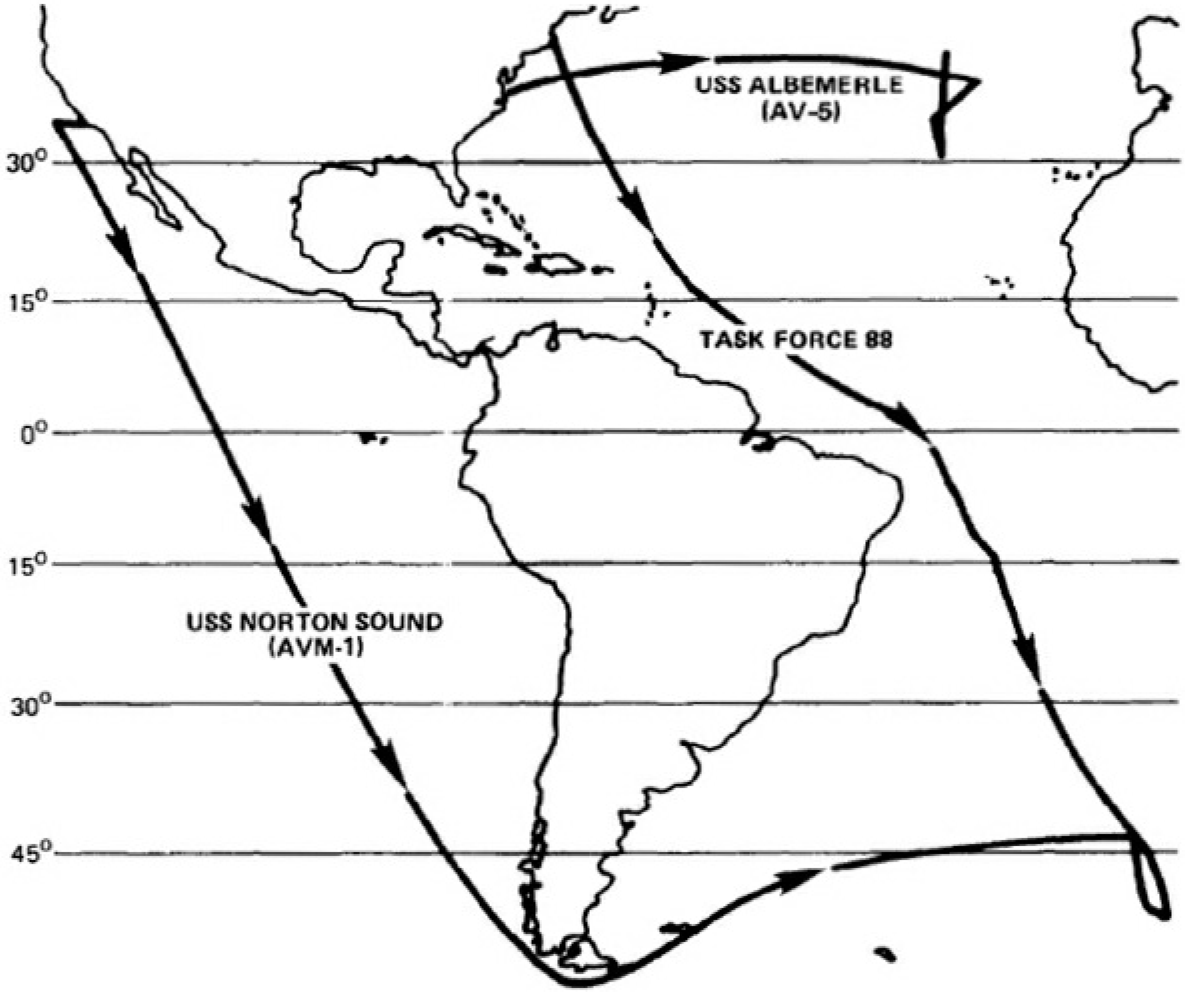
ARGUS 1, Positions of Task Force 88 units and reported bursts.



ARGUS 2, locations of ships at burst time.



ARGUS 3, locations of ships at burst time.



TASK FORCE 88 RETURNED TO NEWPORT, RHODE ISLAND, VIA RIO DE JANEIRO

USS ALBEMARLE (AV-5) RETURNED TO NORFOLK, VIRGINIA, DIRECTLY

USS NORTON SOUND (AVM-1) RETURNED TO PORT HUENEME, CALIFORNIA, VIA RIO DE JANEIRO AND THE PANAMA CANAL

USS NEOSHO (AO-143) AND USS BEARSS (DD-564) RETURNED TO NORFOLK, VIRGINIA, VIA RIO DE JANEIRO

USS SALAMONIE (AO-26) RETURNED INDEPENDENTLY TO NEWPORT, RHODE ISLAND

Task Force 88 track chart, 1 August to 6 September 1958, ARGUS

Notes

Introduction

1. Walter Sullivan, *Assault on the Unknown* (New York: McGraw Hill, 1961), 140–41; Walter Sullivan, “News of Atom Test Took 2 Years To Reach Island 60 Miles Away,” *New York Times*, October 31, 1960.

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1. Abigail Foerstner, *James Van Allen: The First Eight Billion Miles* (Iowa City: University of Iowa Press, 2007), 144.
2. Sharon Weinberger, *The Imagineers of War: The Untold Story of DARPA, the Pentagon Agency That Changed the World* (New York: Alfred A. Knopf, 2017), 32–3.
3. Paul Dickson, *Sputnik: The Shock of the Century* (New York: Simon & Schuster, 2001), 137.
4. Herbert York, *Making Weapons, Talking Peace* (New York: Basic Books, 1987), 101.
5. Dickson, *Sputnik*, 146.
6. Quoted in Evan Thomas, *Ike’s Bluff: President Eisenhower’s Secret Battle to Save the World* (New York: Little, Brown, 2012), 280.
7. York, *Making Weapons*, 131.
8. U.S. Department of Energy, *Briefing to Admiral Arleigh Burke, Chief of Naval Operations, The Argus Experiment*, July 29, 1958, DOE OpenNet (https://www.osti.gov/opennet), NV0059492.
9. Frank H. Shelton, *Reflections of a Physicist: Project Argus* (Colorado Springs, CO: Shelton Enterprises, 2000) 17, slide 58.

Chapter 2

1. Elisheva R. Coleman, Samuel A. Cohen, Michael S. Mahoney, “Greek Fire: Nicholas Christofilos and the Astron Project in America’s Early Fusion Program,” *Journal of Fusion Energy* 30, no. 3 (April 2011), 241,

https://doi.org/10.1007/s10894-011-9392-5

2. This correspondence seems to be the origin of this particular sobriquet, which would subsequently come to be inextricably linked with Christofilos, at first only in private and professional circles and then finally by the public and press at large. There is no record that Christofilos ever seemed to mind.

3. Edward Teller, Biography of Nicholas C. Christofilos, April 8, 1959, Nicholas C. Christofilos Papers, Lawrence Livermore National Laboratory Archives.

4. Somehow, the usually impeccable *Physical Review* copyeditors overlooked the misspelling of "synchrotron" in the title of the paper, though the word is correctly spelled in the text.

5. Robert P. Crease, *Making Physics: A Biography of Brookhaven National Laboratory, 1946–1972* (Chicago: University of Chicago Press, 1999), 219.

6. Quoted in Crease, 220.

7. Coleman et al., 241.

8. York, *Making Weapons*, 130.

Chapter 3

1. The capitalization styles for code names of nuclear test series and shots in the primary literature vary greatly among different agencies, departments, and time periods. For consistency's sake in this book, except for those contained in direct quotations, only the names of test series (e.g., DOMINIC) are fully capitalized, while individual shots (e.g., Starfish) are not. The one exception is Argus, which is the only US test series that did not name individual shots.

2. Defense Threat Nuclear Agency, U.S. Department of Defense, *Defense's Nuclear Agency, 1947–1997* (Washington, D.C.: U.S. Government Printing Office, 2002), 137.3. York, *Making Weapons*, 131.

3. York, *Making Weapons*, 131.

4. *Defense's Nuclear Agency*, 137.

5. James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge, MA: The MIT Press, 1977), 187–88.

6. Foerstner, 193.

7. Ibid., 180.

8. George H. Ludwig, *Opening Space Research: Dreams, Technology, and Scientific Discovery* (Washington, D.C.: American Geophyiscal Union,

2011), 362.

9. James A. Van Allen, “Energetic Particles in the Earth’s Magnetic Field,” in *Discovery of the Magnetosphere*, ed. C. Stewart Gillmor and John R. Spreiter (Washington, D.C.: American Geophyiscal Union, 1997), 240.

10. Ludwig, Opening Space, 365.

11. Van Allen, “Energetic Particles,” 243.

12. Ibid., 243.

13. Ibid., 244.

14. Foerstner, 190.

15. Ibid. 191.

Chapter 4

1. Defense Nuclear Agency, U.S. Department of Defense, United States Atmospheric Nuclear Weapons Tests, Nuclear Test Personnel Review, *Operation Argus 1958* (Washington, D.C.: U.S. Government Printing Office, 30 April 1982), DNA 6039F, 18. (Henceforth DNA report)

2. Lisa M. Mundey, “The Civilianization of a Nuclear Weapon Effects Test: Operation ARGUS,” *Historical Studies in the Natural Sciences*, vol. 42, no. 4 (2012), 298.

3. Ibid., 295.

4. DNA report, 18.

5. York, *Making Weapons*, 117.

6. Dr. James R. Killian, Jr., “Report of NSC Ad Hoc Working Group On the Technical Feasibility of a Cessation of Nuclear Testing,” March 27, 1958, 7, The National Security Archive, Washington, D.C.

7. York, *Making Weapons*, 149.

8. Transcript, *The Reminiscences of Vice Admiral Lloyd M. Mustin, U.S. Navy (Retired), Volume II*, interviewed by John T. Mason, Jr., August 28, 1974; September 4, 1974; October 23, 1974; October 30, 1974; December 18, 1974; January 15, 1975 (Annapolis, MD: U.S. Naval Institute, 2003), 1200.

9. Transcript, Lloyd M. Mustin interview, September 22, 1980, 15, DOE OpenNet (https://www.osti.gov/opennet), NV0068994.

10. DNA report, 25.

11. Ibid.

12. Mustin, *Reminiscences*, 1215–6.

13. Ibid., 1212.

14. Ibid.

15. Ibid., 1207.
16. Ibid., 1205.
17. Ibid.
18. Ibid., 1206–7.

Chapter 5

1. Defense Nuclear Agency, U.S. Department of Defense, United States Atmospheric Nuclear Weapons Tests, Nuclear Test Personnel Review, *Operation Hardtack I 1958* (Washington, D.C.: U.S. Government Printing Office, 1 December 1982), DNA 6038F, 259.
2. *Defense's Nuclear Agency*, 140.
3. James Rodger Fleming, "Iowa Enters the Space Age: James Van Allen, Earth's Radiation Belts, and Experiments to Disrupt Them," *The Annals of Iowa* 70 (Fall 2011), 314.
4. *Defense's Nuclear Agency*, 140.
5. *Operation Hardtack I 1958*, 257–73.
6. *Defense's Nuclear Agency*, 142–3.
7. Ludwig, 370.
8. Mustin, *Reminiscences*, 1217.
9. Ludwig, 369–70.
10. Richard S. "Dick" Culp, telephone interview with author, August 2, 2016.
11. Frank Shelton, "Reflections of a Physicist, 67.
12. Keith Mayfield, email interview with author, September 14, 2016.
13. Mustin, *Reminiscences*, 1210.
14. Mayfield, ibid.
15. Shelton, 65.
16. Mustin, *Reminiscences*, 1213.
17. McMaster email interview, September 17, 2016.
18. Culp interview.

Chapter 6

1. Mustin 1980 interview, 9.
2. Mustin, *Reminiscences*, 1218.
3. Ibid.
4. U.S. Defense Atomic Support Agency, L.M. Mustin, RADM, USN,

Operation ARGUS: Report of the Commander, Task Force 88, March 31, 1960, DOE OpenNet (https://www.osti.gov/opennet), 23. (NV0133192)

5. Mustin, *Reminiscences*, 1217.
6. Ibid., 1220.
7. Ibid., 1209–10.
8. Ibid. 1223.
9. Ibid., 1208.
10. *Operation ARGUS: Report of the Commander, Task Force 88* (NV 0133192) 36.
11. Culp interview.
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Films

The atmospheric nuclear testing years of the United States were well-documented by official agencies, mostly the US Air Force's Air Photographic and Charting Service at Lookout Mountain Air Force Station in California. Lookout Mountain's dedicated and fearless corps of filmmakers developed new photographic technologies to document the unique phenomena of nuclear explosions. Most (but not all) of their work has been declassified and is readily available online at YouTube and other sources, and provides an invaluable historical record.

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Those wishing to see for themselves the ominous grandeur of nuclear detonations in the atmosphere and outer space are directed to the work of filmmaker Peter Kuran, who has meticulously restored and edited much of Lookout Mountain’s original work in new documentary films.

Kuran, Peter. *Nukes in Space: The Rainbow Bombs*. DVD. Directed by Peter Kuran. Thousand Oaks, CA: Goldhil Home Media International, 2000.

Abbreviations and Acronyms

AAAS	American Association for the Advancement of Science
ABM	Anti-ballistic missile
ABMA	Army Ballistic Missile Agency
AEC	Atomic Energy Commission
AFSWP	Armed Forces Special Weapons Project
ARPA	Advanced Research Projects Agency
ASAT	Anti-Satellite (i.e., weapons)
CNO	Chief of Naval Operations
DASA	Defense Atomic Support Agency
DNA	Defense Nuclear Agency
DOD	Department of Defense
ELF	Extremely low-frequency
EMP	Electromagnetic pulse
ICBM	Intercontinental Ballistic Missile
IGY	International Geophysical Year
JCAE	Joint Committee on Atomic Energy
JPL	Jet Propulsion Laboratory
JTF	Joint Task Force
JTF-8	Joint Task Force 8
LLNL	Lawrence Livermore National Laboratory
NAS	National Academy of Sciences
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NOTS	Naval Ordnance Test Station
PSAC	President’s Science Advisory Committee
SUI	State University of Iowa
TF 88	Task Force 88
TI	Texas Instruments

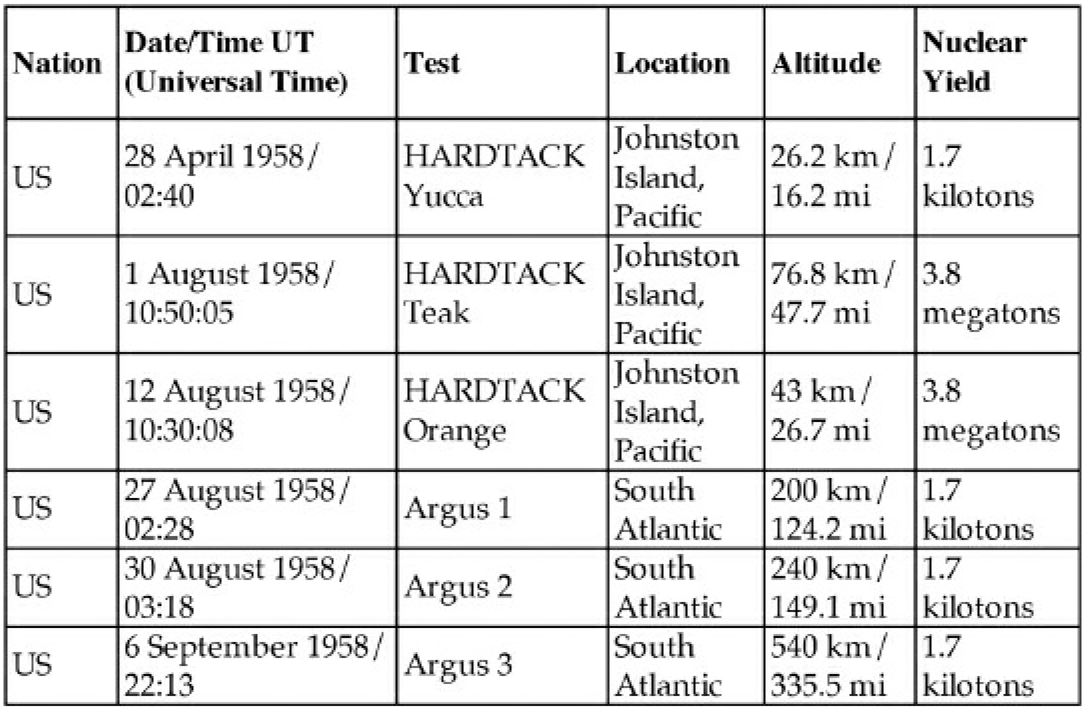
UCRL University of California Radiation Laboratory

Timeline of Outer Space/ High Altitude Nuclear Tests

The generally accepted boundary between Earth’s atmosphere and “outer space” is most often demarcated by the “Kármán line” (after the Hungarian-American physicist and aeronautical engineer Theodore von Kármán), at an altitude of 100 kilometers (62 miles) above sea level. Other tests are considered merely “high altitude” or “near space.”

This list does not include failed shot attempts, but only those with confirmed nuclear detonations.

Of special note is the frantic pace of tests by both the US and USSR in October and early November 1962, coinciding with the approximate period of the Cuban Missile Crisis, which although not directly related, undoubtedly helped to ratchet up the level of international tension.



Nation	Date/Time UT (Universal Time)	Test	Location	Altitude	Nuclear Yield
US	28 April 1958 / 02:40	HARDTACK Yucca	Johnston Island, Pacific	26.2 km / 16.2 mi	1.7 kilotons
US	1 August 1958 / 10:50:05	HARDTACK Teak	Johnston Island, Pacific	76.8 km / 47.7 mi	3.8 megatons
US	12 August 1958 / 10:30:08	HARDTACK Orange	Johnston Island, Pacific	43 km / 26.7 mi	3.8 megatons
US	27 August 1958 / 02:28	Argus 1	South Atlantic	200 km / 124.2 mi	1.7 kilotons
US	30 August 1958 / 03:18	Argus 2	South Atlantic	240 km / 149.1 mi	1.7 kilotons
US	6 September 1958 / 22:13	Argus 3	South Atlantic	540 km / 335.5 mi	1.7 kilotons

USSR	6 September 1961 / 06:00	#88 Groza ("Joe 79")	Kapustin Yar, USSR	22.7 km / 14.1 mi	10.5 kilotons
USSR	6 October 1961 / 07:15	#115 Grom ("Joe 98")	Kapustin Yar, USSR	41.3 km / 25.6 mi	40 kilotons
USSR	27 October 1961 / unknown	K Project #127	Kapustin Yar, USSR	150 km / 93.2 mi	1.2 kilotons
USSR	27 October 1961 / unknown	K Project #128	Kapustin Yar, USSR	300 km / 186.4 mi	1.2 kilotons
US	9 July 1962 / 09:00	DOMINIC / FISHBOWL Starfish Prime	Johnston Island, Pacific	400 km / 248.5 mi	1.4 megatons
US	20 October 1962 / 07:30	DOMINIC / FISHBOWL Checkmate	Johnston Island, Pacific	147 km / 91.3 mi	uncertain; approx. 7 kilotons
USSR	22 October 1962 / 03:40:45	K Project #184	Kapustin Yar, USSR	290 km / 180.1 mi	300 kilotons
US	26 October 1962 / 08:59	DOMINIC / FISHBOWL Bluegill Triple Prime	Johnston Island, Pacific	48.2 km / 29.9 mi	400 kilotons
USSR	28 October 1962 / 04:41:20	K Project #187	Kapustin Yar, USSR	150 km / 93.2 mi	300 kilotons
USSR	1 November 1962 / 09:12	K Project #195	Kapustin Yar, USSR	59 km / 36.6 mi	300 kilotons
US	1 November 1962 / 11:10	DOMINIC / FISHBOWL Kingfish	Johnston Island, Pacific	96.3 km / 59.8 mi	400 kilotons
US	4 November 1962 / 06:30	DOMINIC / FISHBOWL Tightrope	Johnston Island, Pacific	21 km / 13 mi	uncertain; approx. 7 kilotons

Author’s Note and Acknowledgments

Even if Operation Argus had actually been “the greatest scientific experiment of all time” as it was breathlessly proclaimed, such hyperbole hardly holds up sixty years later, in a world with smart phones, molecular biology, and the Large Hadron Collider. But in its time, it was certainly one of the most secretive. As they all played their various parts to bring Argus to its successful conclusion, practically none of its direct participants were aware of the full picture. One telling example is the crew scrapbook of the *Norton Sound*’s 1958 summer cruise, titled *The Horned Shellback*. It features plenty of photos of the ship, its officers and crew, the initiation of pollywogs in the “crossing the line” ceremonies, icebergs and aircraft, even liberty in Rio—but nothing at all from the mysterious doings of the *Sound* during its weeks in the South Atlantic Ocean. It’s as if a whole chunk of pages has been torn out covering the time from the ship “rounding the Horn” until her arrival in Rio de Janeiro.

While the crew scrapbook wasn’t an official document and hence not formally redacted by upper echelons, it’s probable that the crew was under orders to avoid taking any snapshots of the highly secret Argus activities. Even official visual documentation of Task Force 88’s operations in late August and early September 1958 is almost nonexistent, save for some grainy and unedited 16mm footage that survives in the National Archives and the scenes included in the official (and formerly classified) film reports. The *Norton Sound* logbooks for that period simply list her cruise as beginning from Port Hueneme and ending at a “special project firing area, south Atlantic Ocean”—accompanied by a note from Captain Gralla that the commander of Task Force 88 “has directed all ship’s deck logs classified as Confidential for operations conducted south of latitude 20 S.”

Such missing pieces are quite familiar to researchers of previously classified history. It’s necessary to become something of a detective, hunting down evidence, piecing together clues, seeking connections, and engaging in educated, if reluctant, speculation where necessary—which leads to the frustrating realization that it's virtually impossible to tell the entire story. Inevitably, those missing pieces, whether still classified or simply lost or destroyed over the years, leave some parts of the tale forever clouded, never to be fully known. As previously noted, this problem is particularly marked in the case of Argus, since the breakneck pace of the operation coupled with its intense secrecy meant that many important aspects weren't formally recorded and chronicled in the usual manner of such undertakings.

I say all this not to excuse any inadequacies on my part in telling this story, but to point out that many similar tales remain lurking in the shadows of the Cold War, waiting to be discovered. I've done my best in this book to chronicle the histories of Argus and Fishbowl, but with the full awareness that there are likely more details and more secrets yet to be revealed, not only about these projects but many others. I hope that this volume may serve as a starting point for future efforts, and look forward to learning the secrets that I wasn't able to uncover.

One fact that's not at all secret is that no author can possibly create a book such as this one without the help and support of a great many people. I must first thank my agent, Michelle Tessler, who was the first to believe in this project and relentless in her efforts to place it. I'm also deeply grateful to my colleague Sharon Weinberger, who not only offered helpful guidance on research sources but also referred me to Michelle. At The Overlook Press, Tracy Carns and Chelsea Cutchens provided stalwart editorial guidance.

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